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GROUND-SLOTHS.

By R. Lydekker, B.A.Cantab.

SUFFICIENTLY protected from all attacks on the part of the wolf-like marsupials, and such other large carnivorous mammals as may at the same period have roamed over Argentina, the pigmy glyptodont of the Santa Cruz beds of Patagonia could have had difficulty in maintaining its existence against foes of all kinds, and subsequently giving rise to the gigantic mailed monsters which we endeavoured to describe in our last article. Side by side with this well-defended creature there lived, however, another not less remarkable mammal, of nearly similar dimensions, and likewise belonging to the great order of edentates, then, as now, so characteristic of South America. This creature had, however, no such coat-of-mail as that which defended its contemporary (though there is a possibility that some bony granules may have been imbedded in its undefended skin), and as it appears to have been equally devoid of weapons of offence, while it did not derive protection from an arboreal life, it may be a matter of wonder how it managed to fight its way through the struggle for existence. That it did so is, however, perfectly clear, since the pigmy ground-sloth, as the animal in question may be called, is clearly the ancestral type from which were subsequently evolved those gigantic edentates of the Pleistocene deposits of the Argentine scientifically known by the names of *Megatherium*, *Mylodont*, etc., but which may be collectively designated ground-sloths. These, although unprotected by any means of defence, being among the most gigantic of mammals had, it is needless to say, no difficulty in holding their own; and it is only with regard to their pigmy ancestors that we have any cause for wondering how they managed to survive. Possibly, however, these pigmy ground-sloths were burrowing creatures, like the great anteater of the present day, and lived in holes excavated by their powerful claws; and if this should be the case, the difficulty as to their survival vanishes.

Sloths are, however, such essentially arboreal creatures, as characteristic of the Brazilian forests as are squirrels and dormice of our own woods, that our readers will want to know what we mean by using such an apparently contradictory term as ground-sloths.

To justify ourselves, and at the same time to enable our readers properly to understand the structure of these strange extinct edentates, we must enter into a short dissertation on the subject of sloths, and likewise of their distant cousins the anteaters.

The external form and long shaggy hair of the sloths are too well known to require description, and we accordingly pass on to draw attention to certain peculiarities in regard to their skeletons and teeth which will aid in explaining the reason for the term ground-sloths. In the first place, then, sloths (which, as all our readers are doubtless aware, are comparatively small animals) are characterized by their peculiarly short and rounded heads, which have an almost spherical form. If we examine the skull of one of these animals, we shall find, as in those of other members of the same order, a total absence of front teeth; while the cheek-teeth comprise five pairs in the upper, and four in the lower jaw.

Those who recall our article on "Armadillos and Aard-Varks," published in an earlier number of this journal, will not fail to recollect that in all edentates the teeth are devoid of the hard enamel so characteristic of those of other mammals. In the sloths we find that the teeth form short cylinders, of which the outer layer is harder than the central core, in consequence of which their grinding surfaces become slightly cup-shaped. In the three-toed sloths (*Bradypus*) the whole of the teeth are of this extremely simple type; but in their two-toed cousins (*Cholæpus*) the first pair in each are longer than either of the others, and are modified into a somewhat tusk-like form, the upper ones wearing against the front of the lower ones so as to produce by mutual attrition an oblique bevelled surface at the top of each. The limbs of the sloths are remarkable for their length and slenderness, but the front pair are much longer than the hinder ones. The narrow and curved feet terminate in long hooked claws, which in the three-toed species are three in number in each foot, although in the fore feet of the two-toed sloth they are reduced to a pair; in fact, the feet are reduced to the condition of little more than hooks, admirably adapted for suspending the animal back-downwards from the boughs of trees, but forming poor instruments for terrestrial progression, sloths when on the ground walking slowly and awkwardly, with the soles of the feet turned inwards, and the weight of the body supported on their outward edges. It is important to notice that in the skeleton of the feet the terminal bones, or those ensheathed in the long claws, are not longitudinally grooved on the upper surface.

The South American, or true anteaters, one of which is terrestrial, while the other two are more or less arboreal in their habits, are so unlike the sloths that it is difficult to believe they have any near relationship with the latter;

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and, indeed, were it not for the extinct creatures forming the subject of the present article, it would have been very difficult to discover how close the connection between these two groups really is. In place of the short and rounded heads of the sloths, the anteaters have the head greatly elongated and very slender, while the thin jaws are totally devoid of teeth, and the tongue is long, cylindrical, and highly extensile. There is, however, some degree of variation in regard to the degree of elongation of the skull, the maximum development occurring in that of the great anteater. If possible, a still greater difference obtains in the structure of the feet, the fore foot of the great anteater having five toes, of which the middle one is vastly more powerful than either of the others; while all but the fifth have strong claws. In walking, the extreme outer side and part of the upper surface of the fore foot are applied to the ground; but in the hind foot, which has the fourth toe the largest, and all the five digits furnished with claws, the whole of the short sole touches the ground in the ordinary manner. An important difference from the sloths is to be found in the circumstance that the bones of the terminal joints of the feet have a longitudinal median groove on the upper surface at their tips.

With these preliminary remarks on some of the leading features of the sloths and anteaters, the reader will be in a position to appreciate the peculiarities in the structure of the ground-sloths, and likewise to understand the appropriateness of the name by which they are designated.

Apparently the first of these extinct animals known in Europe was the giant ground-sloth, or *Megatherium*, of which a nearly complete skeleton was discovered in the year 1789 near Lujan, in the province of Buenos Ayres. This skeleton was soon after sent to Madrid, and described by Cuvier in 1798, who gave to the animal to which it belonged the name by which it has ever since been known. If we desired to be hypercritical, we might convict the great anatomist of not having formed this name according to strict rule, for it ought clearly, as in the analogous instance of *Megalosaurus*, to have been *Megalotherium*, instead of *Megatherium*; but let this pass. Cuvier recognized the affinities of the megathere to the sloths; and other skeletons subsequently obtained from the Pleistocene deposits of Buenos Ayres, and which are now in the museum of the Royal College of Surgeons, the British Museum, and the museums of Milan, Paris, and La Plata, have in their turn served to confirm the general truth of the original determination.

One of the most gigantic of land mammals, measuring somewhere about eighteen feet in total length, the megathere, although having a rather more elongated skull, agrees with the sloths in the number of its teeth. In structure, however, these teeth, of which the four lower ones are represented in the accompanying

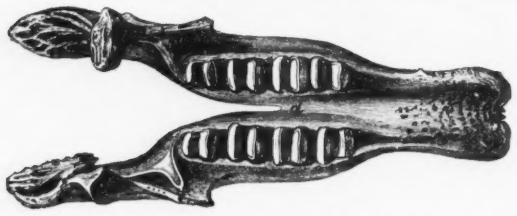

Fig. 1.—Upper surface of the Lower Jaw of the Megathere. One-eighth natural size. (After Owen.)

figure of the lower jaw, are decidedly different to those of the sloth. In form they are square prisms, with a length of over ten inches, and a diameter of fully an inch and a half. The summit of each individual tooth carries a pair of transverse ridges, produced by the alternation of vertical plates of different hardness in the tooth itself; and since the teeth are rootless and grow continuously throughout the life of their owner, this transversely-ridged structure is likewise permanent. To contain such enormous teeth, the lower jaw is remarkably deepened in the middle of its length, where it descends suddenly. The long median channel shown in our figure extending between and in front of the anterior teeth, is evidently for the reception of a large and fleshy tongue, which from its size was probably extensile like that of the giraffe.

If we had only the megathere to deal with, we might have some hesitation, judging from the skull and teeth (which in the group are the only portions of the skeleton showing sloth-like affinities), in regarding the group of animals to which it belongs as closely allied to the sloths. Fortunately, however, the same Pleistocene deposits of Buenos Ayres (to say nothing of the caverns of Minas Geraes, in Brazil) have yielded us remains of other and somewhat smaller ground-sloths, known as mylodonts,

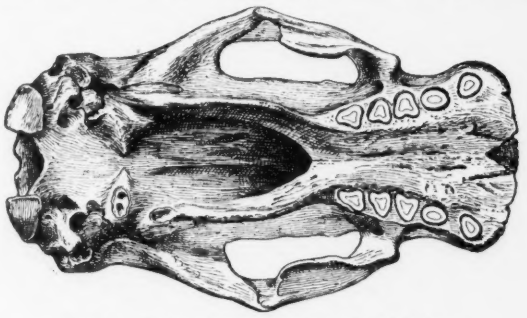

Fig. 2.—Under view of the Skull of a Mylodont. One-sixth natural size. (After Owen.)

which effectually bridge, in these respects, the gap between the megathere and the sloths. In these animals, as shown in our second illustration, the teeth are either cylindical or triangular in section; and from having a harder external coat, wear in the same cup-shaped manner as those of the latter. Moreover, in some mylodonts the front pair of teeth in each jaw have the elongated tusk-like form and oblique wear characterizing those of the two-toed sloth, while in others they resemble the hinder teeth, as in the three-toed sloth. We thus have an exact parallelism in this respect among the mylodonts to the two genera of sloths; and as their skulls in their more rounded and shorter form, and the absence of a descending expansion in the middle of the lower jaw, are likewise more sloth-like than is the skull of the megathere, we can have no hesitation in regarding the ground-sloths, so far as cranial characters are concerned, as closely allied to the sloths. It may be added that the great divergence of the two series of teeth in our figured mylodont skull indicates the presence during life of a tongue of great width and size.

Thus far we have been showing how the ground-sloths are related to the sloths in the characters of their skulls; but other members of the group, known as the scelidotheres (*Scelidotherium*), although still retaining the same number of teeth, show a certain approximation in these respects to the anteaters. Thus their skulls, instead of being short and broad like those of the mylodonts, are very long and narrow, and have the muzzle much produced in advance

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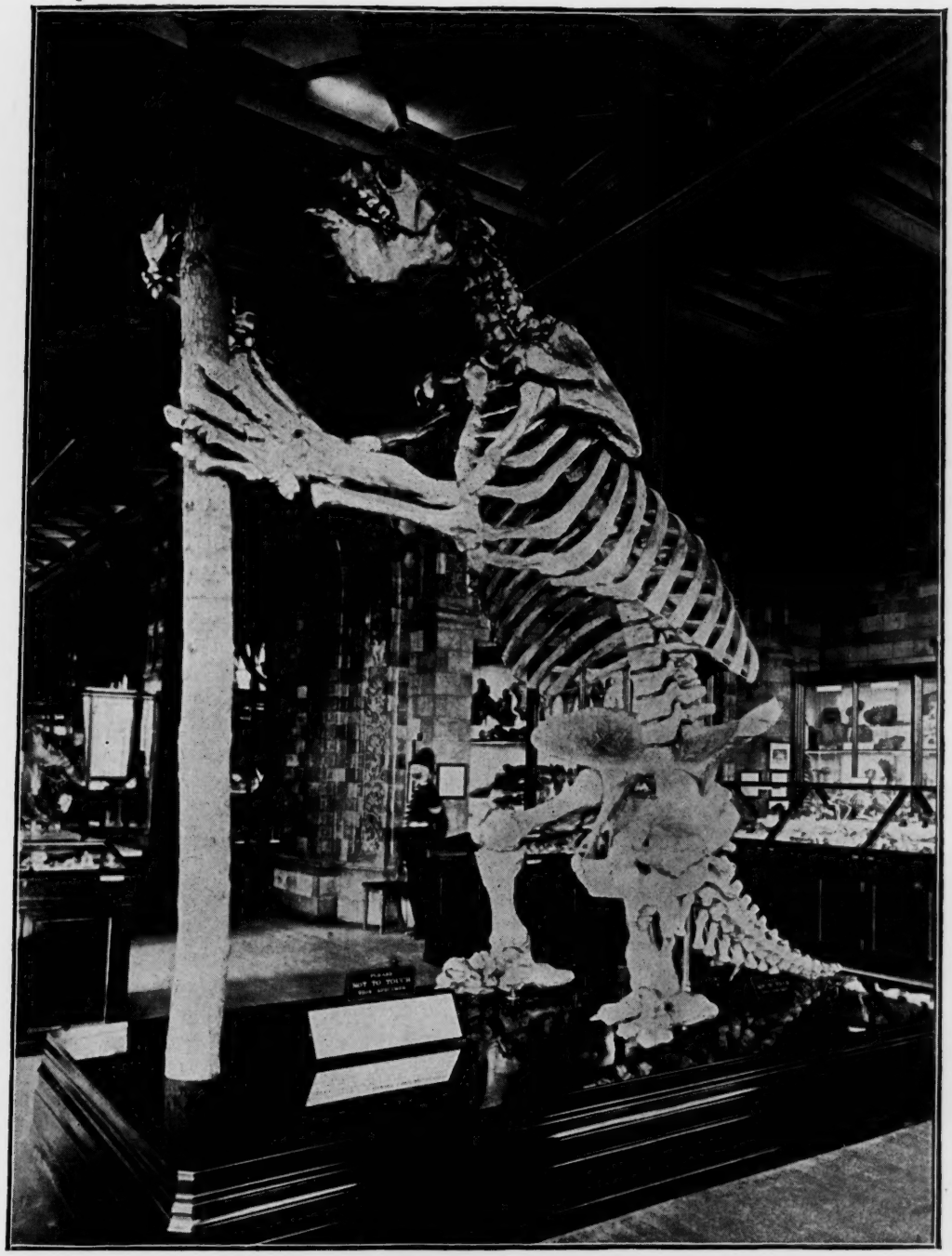

SKELETON OF THE GIANT GROUND-SLOTH OR MEGATHERE. From Lujan, Buenos Ayres.

This Specimen, which is in the British Museum, measures about eighteen feet in total length.

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of the anterior teeth. Indeed, it would require only a still greater elongation and narrowing of the skull of a scelidothere, coupled with the total loss of the teeth, to produce one very similar to that of an anteater.

So far as we are aware, palæontologists have not yet been able to trace a complete transition from the gigantic ground-sloths of the Pleistocene deposits of Buenos Ayres to their diminutive representatives from the older Tertiary deposits of Patagonia, although it is known that some of the species from the intermediate forms were inferior in point of size to their more recent allies. It is, however, very interesting to find that the pigmy ground-sloths of these Patagonian deposits had transversely-ridged prismatic teeth like those of the megathere, and not the cylindrical or triangular ones of the mylodonts, scelidotheres, and megathere; thus apparently indicating that the former type of tooth is the oldest. The contrast between the pigmy ground-sloth and the giant ground-sloth (*Megatherium*) is, however, most remarkable. The total length of the skeleton of the former was only about three feet; while its skull was less than six inches, whereas the skull of the megathere was over a couple of feet in length. Then, again, the whole series of five upper teeth occupy in the pigmy ground-sloth a space of less than an inch and a half, or less than the diameter of a single tooth of its gigantic relative. That such a diminutive creature, if as naked and undefended as its huge cousin appears to have been, needed some special protection, is pretty evident; and it is the need of such defence from attack that has led us to suggest that the creature may have lived in holes excavated by its powerful claws.

Leaving for a moment the mutual relationships and affinities of all these different animals, we have to direct a short glance at the skeleton of the body and limbs of the ground-sloths. In the first place, this differs from that of the sloths in the shortness and extreme massiveness of the limbs, and especially in the extraordinary stoutness and width of the bones of the hind leg and pelvis. In the general form of the scapula or blade-bone, and more especially in the presence of a complete pair of clavicles or collar-bones, the ground-sloths resemble the sloths and differ from the anteaters; the clavicles of the latter being rudimentary. The skeleton of the fore foot is, however, essentially that of an anteater, the inner toe being rudimental, the next three, and more especially the middle one, being enormously enlarged and furnished during life with huge claws, while the outermost was small and clawless. That during life the creature rested on the outer side of this fifth claw and the backs of the three large ones, in anteater fashion, may, from the structure and arrangement of their bones, be considered certain. Unlike the anteater, in which, as we have seen, it rests upon the sole, the hind foot of the Pleistocene ground-sloths is even more strangely modified than the front one, these creatures walking only on its outer edge, while the enormous middle toe, with its gigantic claw, does not appear to have touched the ground in walking and was thus always kept sharp. The first toe is wanting, and the second rudimentary, while the two outer ones were relatively small and unprovided with claws. Some idea of the gigantic proportions of the megathere may be gathered from the circumstances that its hind foot measures nearly a yard in length. Of the pigmy ground-sloths of Patagonia the complete skeleton has not yet been described; but so far as our recollection of a specimen in the La Plata Museum carries us, we believe that it was not of the extremely specialized type characterizing the gigantic forms. Moreover, while in the larger forms the terminal joints of the feet were neither grooved nor split at the extremities, in the small Patagonian species these were deeply cleft at the end, after the fashion obtaining in the scaly anteaters or pangolins of India and Africa. As regards the structure of the vertebral column, the ground-sloths exhibit certain peculiarities distinctive of the anteaters, and which are only rudimentary in the sloths.

When we add to the foregoing brief survey of the chief structural peculiarities of the skeleton of the extinct edentates forming the subject of the present article the circumstance that, from their enormous size, they must necessarily have been terrestrial in their habits, we are in a position to realize the appropriate nature of the term ground-sloths by which they are designated. These creatures may, in fact, be briefly described as edentates having a skull, teeth, and shoulder-girdle very similar to those of the sloths; while as regards their back-bone and feet they come very close to the anteaters, although in the later and more gigantic forms the specialization characterizing the fore feet of the latter has been extended to the hinder pair.

We now come to the interesting question of the mutual relationships and phylogeny of the three groups of edentates discussed in the course of the foregoing paragraphs. Now, in the first place, we shall have little hesitation in regarding the pigmy ground-sloths, which are the earliest known representatives of the group, as the direct ancestors of the gigantic megathere. A modification in the structure of the teeth would equally well permit of their having likewise been the ancestors of the mylodonts, which, as we have seen, possess sloth-like teeth. This, however, will not permit us to regard the mylodonts as having been the forerunners of the sloths, seeing that the latter have a less specialized type of hind foot; and we must accordingly regard the sloths as being a side-branch derived from the pigmy ground-sloths or some nearly allied form after the acquisition of cylindrical teeth, but before the hind foot had acquired the specialization characterizing the mylodonts and megatheres. Hence the curious structural similarity between the front teeth of some of the mylodonts and the two-toed sloth must be another instance of that parallelism in development to which a special article has already been devoted.

With regard to the anteaters, we have already seen that the fore foot of these animals resembles that of the pigmy ground-sloths in that the terminal joints of the larger toes are marked by a longitudinal groove representing the cleft of those of the latter; and as in both groups the middle toe is the largest, there is no reason why the anteaters should not trace their origin to these same pigmy ground-sloths or a closely allied type. In this case the specialization has resulted in a lengthening of the skull and the loss of the teeth, the hind foot having retained more or less of the primitive type. Here, likewise, we must notice that the resemblance presented by the skull of the scelidotheres to that of the anteaters must be regarded as an instance of parallel development.

From the structure of their teeth, the ground-sloths were evidently vegetarians; and the same may be said of the sloths, which are animals specially modified for the exigencies of a purely arboreal existence. On the other hand, the anteaters, as their name implies, have given up a vegetable diet and taken to living on ants, and to this may be attributed their total loss of teeth. Should germs of teeth ever be found in their jaws during an early stage of existence, we venture to predicate they will approximate in structure to the teeth of the ground-sloths.

Thus ends our survey of the structure and relationships of the extraordinary monsters forming the subject of this article; but we cannot conclude without saying a few words

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as to their probable mode of life and external appearance. As regards the latter, it may be suggested that since both sloths and anteaters are clothed with a thick covering of coarse hair, it is highly probable that the same held good in the case of their extinct relations. Further, from their massive proportions, and also from their kinship to the sloths, it is most likely that the ground-sloths were as slow and deliberate in their movements as the latter. That such monstrous creatures could not have existed in a treeless country like the Argentine pampas has been already indicated in the first of the series of articles of which the present is the conclusion, and we may hence assume that in the days of the ground-sloths Argentina was much like what Brazil is at the present day. Browsing on the leaves and probably on the smaller branches of forest-trees, the ground-sloths doubtless obtained their food by rearing themselves up against the trunks, supported on the tripod formed by their massive hind limbs and powerful tail, the ponderous structure of the pelvis being eminently adapted for maintaining the body in such a posture. The same massiveness of structure conclusively proves that the creatures were not arboreal, since no tree capable of being climbed could carry such an enormous weight. It was suggested, indeed, by Owen that the megathere was in the habit, when reared up in the manner indicated above, of clasping a tree in its arms and swaying it backwards and forwards until it fell with a crash to the ground; but although such a radical mode of procedure may have been occasionally resorted to, we have no right to assume that such was the ordinary habit of the ground-sloths.

THE MAKING OF DIAMONDS.

By Vaughan Cornish, M.Sc., F.C.S.

THE reproduction of the diamond by M. Moissan has put the coping-stone to the work of mineralogical synthesis. For some years past it has been thought that the solution of this problem was merely a matter of time and patience; but it is no little satisfaction to be able to say at last that the thing has been done, for it is indeed a striking illustration of the power over stubborn matter which is won by the patient student of science. In the light of what has now been accomplished, it may not be without interest to refer to what was written in this journal on the subject of the production of diamonds previously to the work of M. Moissan. In Knowledge for May, 1891, at the conclusion of an article on "The Artificial Production of Rubies," the matter was referred to as follows:—

"The great problem in the artificial production of gems is the preparation of the diamond. . . . . In the case of other minerals the successful production has generally only been achieved after a minute study of the mode of natural occurrence, and this has afforded guidance as to the best means of imitating the natural process of formation. It is only of recent years that the diamond has been found in its original matrix, so that materials have been wanting on which to base experimental methods. The chemical nature of the body, a combustible substance, is so different from that of the ruby and most other gems, which are oxides or oxidized materials, that the methods to be employed for its production will probably involve the application of different principles. There is no reason, however, to regard the problem as insoluble. When sufficient guiding data have been obtained, skill will not be wanting to imitate in the laboratory the conditions under which Nature has worked in the formation of this most beautiful product of the mineral world."

What some of these determining conditions might be was indicated in a subsequent paper on "The Diamond Mines of South Africa," which appeared in Knowledge for October, 1891. "To the mineralogist the chief interest of the South African mines lies in the fact that the 'blue rock' or kimberlite appears to be the original matrix of the diamond . . . . . It is worthy of note that a black shale forms one of the surrounding rocks, and pieces of this shale have been found baked and otherwise altered in the blue rock. The suggestion has been thrown out that the diamonds were formed by the alteration of the carbonaceous matter of the shale *under the influence of a moderately high temperature and great pressure.* Such indications are useful as affording suggestions to the experimentalist, to whom in spite of previous failures we must look to tell us definitely how the diamond is formed."

If the diamond be highly heated in the presence of oxygen it takes fire, as is well known, and burns with the formation of carbonic acid. If it be heated not in contact with oxygen it swells up and blackens, reverting to the ordinary charred form of carbon. But the action of heat upon bodies is in many cases very different when they are subjected to high pressure, a principle established by Sir James Hall more than one hundred years ago in his celebrated research on the conversion of chalk into marble, one of the achievements of experimental geology, described in Knowledge for July, 1891.

As will be seen, M. Moissan invoked the aid of pressure to modify the action of heat in his experiments, and produced diamonds from charcoal, a substance of the same nature as the "shale" which occurs in the Kimberley rock. The formation of crystals is, as a rule, best brought about either by sublimation or by cooling a solution. Carbon, however, cannot be distilled or sublimed, and is insoluble in all ordinary solvents, such as water or aqueous solutions of acids and alkalies, or in liquids such as alcohol, ether or benzene. On the other hand, molten metals can take up or dissolve carbon to a not inconsiderable extent, as happens, for instance, in the well-known process of iron-smelting. The molten iron in the blast furnace dissolves some of the carbonaceous fuel, a part of which, when the iron is allowed to cool and solidify, crystallizes out in plates of graphite.

This is an example of the production of a crystalline form of carbon from a non-crystalline variety, and it is at the same time an instance of the artificial formation of a mineral.

M. Moissan, in his experiments, employed iron as a solvent for carbon, which was in the form of charcoal; but he modified the action of heat and the solvent by subjecting the carbon-saturated iron to considerable pressure. It may be noted here that M. Moissan finds the principal constituent in the ash of the native diamond to be oxide of iron. It is known also that native diamonds often contain liquefied gases in cavities of the crystal, and that they are sometimes liable to spontaneous disruption, owing to a state of strain which is probably due to their having been formed under high pressure.

In an earlier series of experiments, iron melted by means of an electric furnace, and raised to a white heat, was allowed to saturate itself with carbon in the form of strongly compressed sugar charcoal. The crucible in which the operation was conducted was then plunged into cold water, which cools the outer portion of metal so as to form an outer layer of solid iron. While this outer coating is still red-hot the crucible is withdrawn from the water, and the cooling proceeds more slowly. To realize what goes on within the jacket of solid iron, we must remember that the still liquid interior is molten iron, containing a

large excess of dissolved carbon, and that iron *expands* in the process of solidifying. Hence, during the process of solidification within the jacket or crust of chilled metal, great pressure is exerted. The process of solidification, therefore, goes on slowly and under great pressure, and examination of the resulting product showed that, under these changed conditions a part only of the surplus carbon had crystallized out as graphite, and that in the residue left after dissolving away all the iron by means of boiling hydrochloric acid and other solvents there was a certain quantity of a denser form of carbon (having a specific gravity of 3 to 3·5), and hard enough to scratch a ruby; and that among these heavier portions of the residue were transparent particles, having a greasy or waxy lustre, and marked with parallel striæ and triangular depressions. These transparent particles burnt when heated to 1050° C. in oxygen gas, and as it appeared, with the formation of carbonic acid; but the particles were too small to allow of a quantitative experiment. Similar results were obtained by the slightly modified method of rapidly cooling an ingot of molten iron saturated with carbon from a temperature of 2000° C. In a few cases small fragments were obtained "*qu'ils ressemblent aux petites fragments de diamant transparents que nous avons rencontrés dans la 'terre bleu' du Cap*" (*Comptes rendus*, February 6th, 1894). The result may be summed up by saying that, up to the date of the experiments described in the above quoted paper, M. Moissan appears to have succeeded in *reproducing that transparent variety of carbon of which native diamonds are composed.* The specimens could hardly be called *diamonds*, although they showed certain characters of the native diamond—*e.g.*, a waxy lustre, and parallel striæ and triangular depressions on the surface.

Since the experiments above described, a happy modification of the method employed has given results of a far superior kind, perfect diamonds being formed, having the distinctive physical peculiarities of the native stone, and of sufficient size for M. Moissan to prove by quantitative chemical experiments upon some of the specimens that they burnt with the formation of pure carbonic acid. In the course of experiments made in former years by other experimenters using other methods, transparent crystalline bodies were obtained which were thought to be diamonds, until their failure to satisfy the carbonic acid test showed that the crystalline particles were not composed of carbon.

Moissan's modified method is as follows:—Iron is saturated with carbon at the white heat of an electric furnace, and under pressure. The crucible containing the molten iron is then quickly lowered to the bottom of a bath of melted lead. This ensures quicker cooling than when the iron is plunged in water, owing to the fact, first, that the white-hot iron does not really come into contact with the water, and secondly, that the lead is a good conductor and carries away the heat rapidly. It seems that the two liquid metals behave towards one another much as oil and water, and the molten iron collects in spherical globules which rise to the surface of the molten lead, the difference in the specific gravity of molten iron and of molten lead being of course very considerable. The surface of the drops of liquid iron which float upon the surface of the lead quickly solidifies, the smaller drops with a diameter of one to two centimètres first, the larger drops after a lapse of a longer time, and the solid little balls of iron are left to float on the molten lead where they cool down. The interior of the balls is of course liquid long after the formation of the solid crust. The tendency of the central parts to solidify is resisted by the solid crust, owing to the fact before mentioned, that iron expands in the act of solidification. Meanwhile a part of the carbon crystallizes out from its solution in the liquid iron. After a time, as the cooling goes on, the lead also solidifies, and the little iron balls are left imbedded in the ingot of lead. Then begins the process of getting at the small quantity of the carbonaceous material which it is desired to examine. The lead which adheres to the iron is dissolved away with nitric acid, the iron itself is dissolved by hydrochloric acid, and further treatment with suitable solvents leaves the sought-for residue, a small quantity of material left after the tedious process of removing by slow chemical means the relatively large mass of metal.

Transparent diamonds are found in the residue having well-defined crystalline faces, striated and marked in the well-known way, and the edges generally curved; they have the high refracting power, the specific gravity, and the hardness of the native stone. The peculiar form known as the *hemihedral* predominates amongst these crystals as in those of native diamonds, and their formation under pressure is found to give rise to the phenomena of anomalous polarization of the light which passes through them, as well as occasionally to spontaneous disruption; characters which, as has been mentioned, are sometimes noticed in the native stone. The diamonds are of course small; one with a diameter of half a millimètre appears to be reckoned a fine specimen. Further practice in working the process will probably enable larger specimens to be obtained, as has been the case with the production of rubies, which are now produced of a size sufficient to be used in the jewelling of watches.

However this may be, the production of diamond is now an accomplished fact, achieved by the patient skill of the same worker who, seven years ago, successfully overcame the great experimental difficulties which had rendered fruitless the many former attempts to isolate the chemical element fluorine.

STINGING INSECTS.—III.

By E. A. Butler.

(*Continued from page* 56.)

ALL the stinging insects hitherto described have carried their weapons at their tail, where they form an instrument more or less closely connected with the process of egg-laying. Our third group of so-called stingers, for in this case the epithet is hardly accurate, comprises those that make punctures with their *mouth* organs, and often cause much pain and inflammation by so doing. The insects, in fact, feed on animal juices, and the "stings" are the necessary results of their attempts to obtain food, and do not form incidents in a hostile demonstration. All the members of this group belong to two orders—the Diptera, or flies, and the Hemiptera, or bugs. Taking the former first, we may remind our readers that we have on former occasions, in the articles on various household pests, discussed at some length the so-called "bites" or stings of some of the greatest sinners in this direction, viz., gnats, mosquitos, fleas, and the stinging house-fly (*Stomoxys*), and these details need not be repeated here. But there are a few other flies that are often very troublesome in the same way, though they do not enter our houses, but only punish us when we invade their domains in woods or marshes. One of the most noted of these has such a blood-thirsty appetite that it has been named *Hæmatopota*, *i.e.*, blood-drinker. It is an inhabitant of damp spots in woods, and though plentiful enough, is hardly likely to be noticed till painful experience in the shape of a sharp and sudden prick on hand or neck awakens us to consciousness of its presence.

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It is a cruel-looking, grey-bodied insect, with speckled wings, and somewhat smaller and slenderer than a blue-bottle fly. During life its eyes are strongly suggestive of an evil nature, for they are green, with three or four crimson bands across them. Their brilliancy, however, disappears after death.

This fly, which is sometimes called the cleg, belongs to a family of evil repute, the *Tabanidæ*, which, from their persecutions of farm quadrupeds, have acquired, as a group, the name of horse-flies. Kirby mentions a striking instance of the severity of the attacks of these creatures. He was driving with another entomologist through Cambridgeshire, when the horse became "bathed in blood flowing from minute wounds made by the knives and lancets of various horse-flies." The larger members of the family are also known as gadflies, a name that has the misfortune of being applied to other flies as well, which are troublesome to cattle as internal parasites, and whose life-history, therefore, is totally different from that of the *Tabanidæ*. Much confusion has thus originated, and can only be avoided by using the scientific instead of the popular name. It must, therefore, be clearly understood that throughout this paper, when using the term gadfly, we are speaking of the non-parasitic gadflies of the genus *Tabanus*, and not of the parasitic ones of the genus *Œstrus*, which belong to quite a different family, and have no stinging power at all. The *Tabani* have further acquired the name of breeze-flies, in consequence, it is said, of the loud buzzing they make during their rapid and headlong flight. These larger kinds are not nearly so common in this country as the cleg, and it is fortunate, at least for our cattle, that such is the case, for with their larger size is associated a proportionately severer bite. There is, however, this to be said in their favour, that, in consequence of their buzzing, you know when they are coming, and can be on the look-out. Such is not the case with the wretched little cleg, which has a silent and almost stealthy flight, giving no warning of its approach, but settling on the skin in a calm and determined way, though with so gentle a touch that the victim is quite unconscious of its presence, if its arrival does not happen to have been seen. It does not run over the skin seeking a good place for attack, but sets to work at once at the spot on which it has alighted. By the time the prick is felt, the six lancets with which the mouth is furnished have already been plunged deep into the skin, and are fixed therein so firmly that, unless the fly chooses to withdraw them, some little force is needed to dislodge the creature. The after effect of the puncture seems, as is generally the case with punctures of this sort, to vary with the sensitiveness of the person attacked. To some it causes only temporary irritation, in others it produces swelling and inflammation which do not subside for some days.

In the articles on gnats and mosquitos above alluded to, we pointed out that the persecuting power is characteristic of one sex only; the males are harmless and inoffensive, and it is in the feminine mouth that all the virulence resides. The same is true of the *Tabanidæ:* the males have much smaller mouth organs than their partners, and have two lancets less, the knife-like mandibles being absent, and they regale themselves with sweets from flowers instead of blood. It is not a little remarkable that in the case of all the insects we have already dealt with, whether the power of irritation resides in the head or the tail, it is without exception the females, whether prolific or abortive, that possess the persecuting power. To this rule, however, the Hemiptera, which we shall consider presently, constitute an exception; in them both sexes possess and use the piercing bristles.

Another very brilliant but exceedingly vicious member of the *Tabanidæ* is the "golden eye" (*Chrysops cæcutiens*) (Fig. 6). It is a trifle larger than the cleg; its black body has an orange band at the base, interrupted with black markings; its wings have a dark cloud along the margin, a dark band stretching across the middle, and another smaller one towards the tip. Even in these parts it is a handsome insect, but it is in the eyes that its greatest glory lies. On seeing the creature for the first time one can hardly suppress an exclamation of admiration and delight, as one gazes at the blaze of brilliance with which the eyes sparkle—it is as though the brightest of gems were set in glowing masses over the head; the ground colour is brilliant golden-green, and scattered over this on each eye there are five deep crimson or purple spots. The hind border of the eye also is set with the same intense colour, and then, as with a gem, there is a change of the appearance as it is regarded first from one point of view and then from another. Like the cleg, this fiery creature is silent in its flight, and the first hint of its proximity is its own brilliant self seen calmly resting, perhaps, on one's coat-sleeve. If this be so we can afford to admire it at leisure, but if it should have dropped silently down on to the bare flesh, the first involuntary thought of admiration will soon be banished by a sharp twinge of pain, and we shall hasten to shake or brush off the offender, heedless of its gems and their lustre. The mouth organs in all the female *Tabanidæ* form a vicious-looking beak pointing downwards from beneath the head, and as the antennæ also have a rather cruel aspect, being short and stiff and curled upwards like little horns, the face of the insect forms a pretty good index to its character.

Fig. 6.—Golden-eye (*Chrysops cæcutiens*). Magnified two diameters.

The gadfly of the ox (*Tabanus bovinus*) is a very fine insect, the bulkiest of all our British Diptera. Like its brethren it has a broad, flattish body, each segment of which is dark at the base and pale at the apex; in the centre the pale margins expand into pale triangles, which form a line down the middle, and by their artistic effect take off something of the otherwise awkward breadth of body. The larva of this fine insect is a footless grub which lives underground, where it appears to feed on the roots of plants and vegetable refuse. While still underground it changes into a spiny chrysalis, and when about to become a perfect fly this chrysalis works its way up through the soil by means of its spines and bristles. In this resting stage it is of course blind, like pupæ in general, and how it knows in what direction to move so as to reach the surface must be left to conjecture. The larva is full grown in May, and the perfect fly appears during the summer, when it becomes a great plague to cattle in districts where it is common, by piercing their hides by means of its powerful set of six lancets, and sucking their blood. This is certainly a strange revolution in tastes; that an insect which in early life is a nibbler of roots should become in adult age a sucker of blood is hardly what would have been expected, though it is by no means an alteration without parallel amongst the order Diptera. A change from solid to liquid food is necessitated by the altered form of the mouth organs, but still there are plenty of vegetable juices available, and it would have seemed more natural had some of these been selected. There are several other species of *Tabanus*, which closely resemble the gadfly in form and adornment, and which are some-

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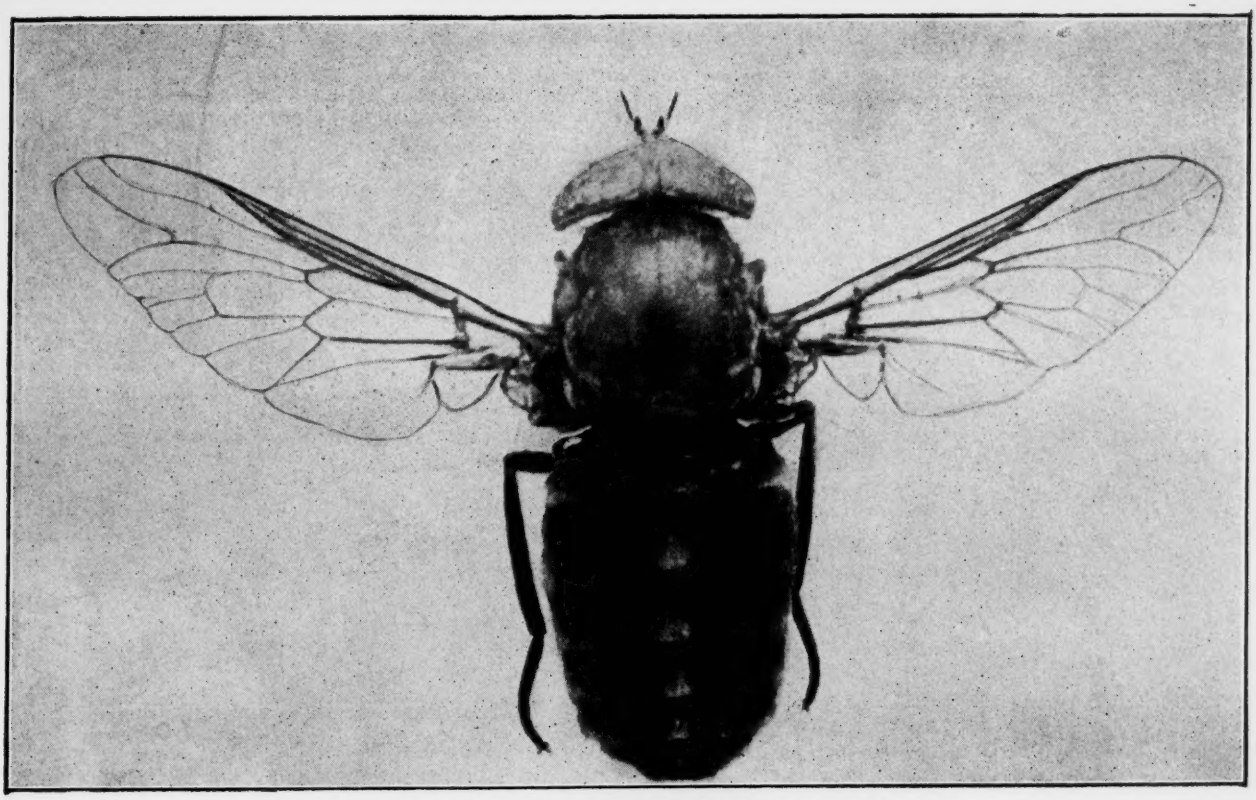
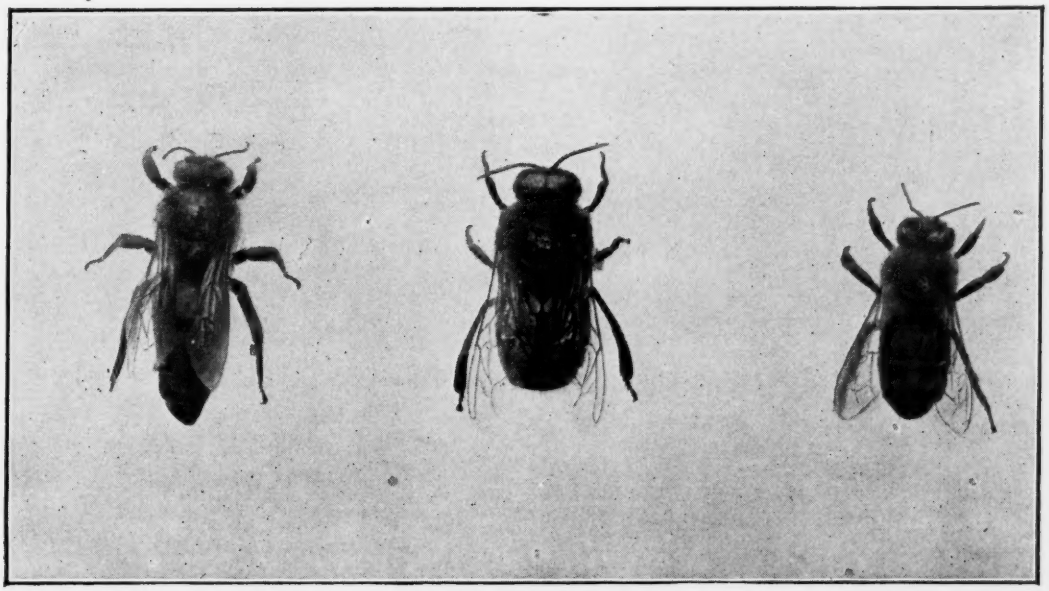


GADFLY *(Tabanus bovinus)*, **the largest British species of the genus.**

With its strong and well-developed mouth organs, which are beneath the head and cannot be seen in the specimen, it pierces the hides of cattle and sucks their blood. Its enormous masses of compound eyes will be noticed occupying nearly the whole of the surface of the head. The two horn-like objects projecting from the front of the head are the antennæ. The first two pairs of legs were bent under the body in the specimen photographed, and only the knees of the first pair can be seen. One of the halteres, or balancers, the substitutes for hind-wings in the Diptera, can be seen as a knobbed stalk just above the left hind leg.



QUEEN BEE. **DRONE.** **WORKER BEE.**

(Apis mellifica).

The queen is the mother as well as the ruler of the hive, being the only perfectly developed female present; her long, pointed abdomen distinguishes her. She is furnished with a sting. The drone is the male bee, and may be known by his broad, bulky body, and longer antennæ; he has very large eyes, which meet on his forehead, and large and powerful wings. Both of these peculiarities give him an advantage in mating with the queen in the air; by his superior sight he can see her at a distance, and by the strength of his wings he can rise above her. He is stingless, and his legs are not provided with the means of collecting pollen, so that he rarely, if ever, visits flowers. The worker is the smallest of the three, and being an imperfectly developed female, is provided with a sting. The workers have depressions on the hind legs for carrying pollen, and by them all the work of the hive is performed.

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times mistaken for it. The true cattle pest may, however, be distinguished by its comparatively gigantic size ; it attains a length of about an inch, and has an expanse of wing of at least two inches, and this is a very large size for a British fly. It flies with a loud hum, and wheels round its prey in large circles before commencing the attack. The female lays some four hundred or five hundred eggs, which are deposited on grass stems, and the larvæ when hatched wriggle down and work themselves beneath the soil, where they soon find appropriate food. A degree of fecundity such as this may well cause this insect to become an intolerable nuisance in any district in which it is well-established, not only to cattle, but to human beings as well, for it is quite ready to attack mankind. Fortunately it is by no means common in this country, and we are therefore tolerably free from molestation.

But even the gadflies have had their apologists. In the days when the "apothecary's" chief instrument was the lancet, and blood-letting was regarded as the universal panacea for human ills, it is scarcely surprising that the idea was entertained that the attacks of gadflies on cattle were not altogether an unmixed evil, but that in fact, by their phlebotomy, these insects might even be a valuable preventive of disease in full-fed animals, and that their incessant attacks, by keeping the cattle in constant movement, were useful in giving them needed exercise, and thus holding in check such diseases as might be generated by indolence and repletion.

In this connection may be mentioned that terrible pest of Central Africa, the tsetse fly. Though such a fearful scourge, it is but a small insect far inferior to the gadfly in size, and indeed not much larger than an ordinary house-fly. According to Livingstone, its attack produces no immediate effect on the cattle, and symptoms of constitutional derangement do not appear till a few days after the puncture has been made. The eyes and nose then begin to run, and swellings appear under the jaws ; though the animal continues to graze, it becomes thin and starved in appearance, and its flesh becomes flaccid and feeble. Some perish at an early stage with staggering and blindness, as though the brain were affected ; others linger on, becoming more and more emaciated, until at last they die of extreme exhaustion, all the organs of the body being more or less diseased.

There is a most remarkable section of the fly order, which contains flies parasitic upon various mammals and birds ; some of them, like the bat-louse and sheep-tick, have no wings, and their popular names reflect the mistakes that have thence arisen as to their zoological position. Though their habits are those of lice and ticks, they are yet true flies—very extraordinary ones, it is true, but still none the less members of the order Diptera though they have no wings. Some near relations of theirs may be appealed to in support of this contention ; the bird-louse or fly (*Ornithomyia*) and the horse-louse or fly (*Hippobosca*) are in shape of body and general habits very much like the sheep-tick, but they have the usual pair of wings of dipterous insects. These insects live upon the blood of their hosts, which they suck up through a fleshy tube leading into the mouth, composed of the labium and maxillæ and provided with piercing bristles. On the death of their host they forsake it at once, and proceed to seek for another; when on this search the bird-louse is not always particular as to the animal from which it shall elect to take its next draught, and if unlucky man should fall in the way he will become the victim. *Hippobosca equina* is a great pest to horses, settling on them as they pass through woods, and running in spirited fashion over their bodies in search of those parts that are least covered with hair. These found, they plunge their straight beak through the skin and greatly irritate the quadruped. Swishing with the tail, the horse's only method of dislodgment, is not very effective, because the flies cling so tightly, and have such tough bodies. By far the most remarkable facts connected with these insects are those that concern their reproduction. They are not prolific, the female producing no more than a single egg at a time ; there is, however, a good reason for this slow rate of increase, for the egg is not actually laid when fertilized, but is retained within the body of the mother, where the larva is hatched and remains during the whole of its larval life. During this time it is fed on a milky secretion furnished within the mother's body, and of course it grows a good deal, and the body of the mother, which is sac-like without evident segmentation, expands to accommodate it. Thus there is no room for more than a single egg. As soon as the immured grub has assumed the pupa state, it is deposited by the mother as a large, soft, white, roundish body which, but for its size, might easily pass for an ordinary egg. As we have seen, however, it is really a pupa, or rather puparium, since, according to fly custom, the real pupa is enclosed in the last larval skin. The apparent eggs, then, laid by the flies of this division are not really eggs at all, but pupæ, and hence the group has been named "Pupipara," *i.e.*, bringers forth of pupæ.

Brief reference may now be made to the Hemiptera. All of these insects possess four piercing bristles in a gutter-like labium, which constitutes a sort of beak, usually carried, when at rest, bent backwards beneath the head. They all feed upon liquids, derived either from animals or plants, the latter being by far the most usual source of supply. As a consequence, only a very few species ever trouble mankind, for even amongst those that are animal feeders it is the rarest thing for man to be the animal selected, and indeed it is usually by accident that such an event happens. Of course there is the bed-bug, which seems to have permanently attached itself to mankind, but beyond this no species can be spoken of as other than quite an occasional and incidental assailant. We have sufficiently discussed our bedroom pest on former occasions, and need now therefore only notice the other species that are likely to trouble us. These are almost entirely to be found amongst water insects, two of which are all that call for notice. The first is the water boatman (*Notonecta glauca*), a well-known inhabitant of ponds, which swims on its back, oaring its boat-shaped body about with the utmost vigour by means of its flat and fringed hind legs, and every now and then resting at the surface with the tip of its body just out of the water for breathing purposes. It is a strong, active, and rapacious insect, wielding an iron rule over the other inhabitants of the pond ; of course it does not eat them, since it has no biting jaws, but it hugs them tight, digs its beak into them, and sucks out their juices. It is a bold and enterprising insect, and very much objects to having its liberties curtailed, so that if caught in a net and then taken into the hands, it is not slow to manifest its indignation by a sharp prick with its beak (Fig. 7.) This, however, can hardly be intended for taking food, but must be regarded as a defensive act. The pain is acute at the moment, but it soon passes off, and no after ill effects are perceived.

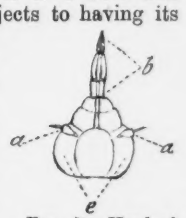

Fig. 7.—Head of Water Boatman, with beak extended. *a*, antennæ; *b*, beak; *e*, eyes. Magnified three diameters.

The other insect is a closely allied species, of a dark olive-brown colour, broad and flat instead of narrow and deep, as the boatman is. It is not so

common as *Notonecta*, and as it lurks amongst pond weeds, is rarely seen except when taken in a net; it appears, therefore, to have no popular name, but is scientifically known as *Naucoris cimicoides*. Its behaviour is much the same as that of *Notonecta*, save that it swims back uppermost, and the pain of its prick is at least as acute, if not more so, and hence most persons would instinctively drop it as soon as they felt the prick, under the impression that a real sting had been received.

The only terrestrial species of Hemiptera that has been found to give a painful prick with its beak is a very common insect found amongst low herbage, such as tufts of grass, rushes, stinging-nettles, &c. It is called *Nabis limbatus* (Fig. 8), and is a long, narrow, brownish insect, with long, slender legs, and rudimentary wings. The female has the body considerably dilated, and marked above with pale orange stripes, which contrast prettily with the more sober colouring of the other parts. Like the other members of its genus, it is active and predaceous, feeding on the juices of other insects. Only one instance has been recorded of its attacking man, and that was under the most exceptional conditions, when the equanimity of any insect might be expected to be disturbed. In 1889, Mr. Eardley-Mason wrote as follows to the *Entomologist's Monthly Magazine*:—"On 1st September last, feeling a sharp sting on my neck, I hastily put up my hand to catch the offender, when, instead of a wasp, it proved to be a *Nabis limbatus*. The sensation was precisely that of a wasp's sting, and the appearance also. The swelling, however, was not nearly so great, and in two hours both it and the irritation had subsided. The insect, I imagine, had been trapped between my neck and shirt collar, and had resorted to its rostrum as a weapon of defence." Such an experience is certainly very rare, and I have myself handled hundreds of these insects without ever having been stung. It was no doubt the awkward position in which the insect found itself that led it to behave in such an unprecedented way.

Fig. 8.—*Nabis limbatus*. Magnified two and a half diameters.

Our final group of stinging insects consists of caterpillars with glandular hairs, such as those of the brown tail and gold tail moths, and the processionary moths of the Continent. As we have already described in detail the powers of these insects in the recent articles on caterpillars, it will be unnecessary to enlarge upon the subject here, and we need only remind our readers that these stings of the fourth class are the only ones that are, as it were, accidental, and independent of the will of the insect, being brought about by the mere contact of an external body with the hairs. Nevertheless, in result they are as painful as the bites and stings already referred to, and give rise to even greater irritation. These are the only group, too, in which the effect may be produced without actual contact with the insect itself; merely holding the head over a box containing the caterpillars is sometimes sufficient to produce considerable swellings and much irritation, no doubt because of fragments of the hairs floating about in the atmosphere.

A word may be added with reference to the accompanying plate. The figure of the gadfly, magnified about three and a half diameters, will speak for itself, as we have described it above. The flattened body, the pale margins of the segments, expanding in the middle into pale triangles, and the forked antennæ, will serve to distinguish it from other two-winged flies. This insect, it will be remembered, carries its weapons around its mouth. The three bees, typical of insects whose weapon is in the tail, represent the "sexes" of the hive bee (*Apis mellifica*), magnified about one and a half diameters. The bulky body, meeting eyes, and longer antennæ and wings, at once distinguish the drone or male bee. The queen being monandrous, and one impregnation lasting her lifetime, only one drone is really required for each queen, so that the annual production of drones is far in excess of actual requirements; and as the queen is caught by her partner in the air, the successful suitor is likely to be one of the finest of the brood, and thus the quality of the breed is maintained. Under ordinary circumstances the drones are of course stingless, but since hermaphroditism occasionally occurs amongst bees as amongst other insects, drones with sting and poison gland complete may be met with—in fact, various admixtures of the sexual peculiarities occur, such as specimens with drone abdomen and thorax and worker head, and the converse; or, more remarkable still, with drone abdomen and thorax and one half of the head worker and the other half drone, as well as the converse of this.

THE GREAT SANITARY LESSON OF THE CRIMEAN WAR.

By G. B. Longstaff, M.A., M.D.Oxon., F.R.C.P., &c.

WAR is a great evil, some would go so far as to say the greatest of all evils; but, bad as it is, horrible as it is, we owe many good things to war, some that few dream of.

It is now forty years since the armies of France and England pitched their camps on the plateau before Sebastopol. The winter of 1854-5 caused unspeakable sufferings to many thousands of brave men. Did they suffer in vain? By no means, but it is quite certain that very few people know in what way we to-day are benefiting from the hardships they endured in those terrible days.

I will quote from one who was there, who studied the object-lesson deeply, who barely escaped with his life, but who lived long after to give to his countrymen in a most practical form the results of his painful studies. J. Netten Radcliffe, late Medical Inspector of the Local Government Board, wrote: "The Crimean war was one of the most important agencies concerned in the development of sound sanitary method and practice in this country"; and he went on to say that its sanitary lessons constitute, probably, the most important legacy left to the nation by that war.*

"The great catastrophe which befell the British army in the Crimea during the winter of 1854-5 was no novelty in our military history, but it occurred under circumstances very different from any that had ever before presented themselves in the wars waged by this country. It occurred at a time when the country had been thoroughly aroused [especially by the cholera epidemic of 1849] to a sense of the supreme importance of the health of the population as affecting the welfare of the nation, and was prepared to take an intelligent interest in all questions relating to the subject. It occurred also under circumstances of publicity such as had never attached to an army in the field before. . . . . Then England learnt for the first time how strangely it had misapprehended the requirements of the soldier. By the electric telegraph, the facility of

* "Sanitary Fundamentals." Two lectures delivered at the Royal Naval College by J. Netten Radcliffe, afterwards published in *The Practitioner*.

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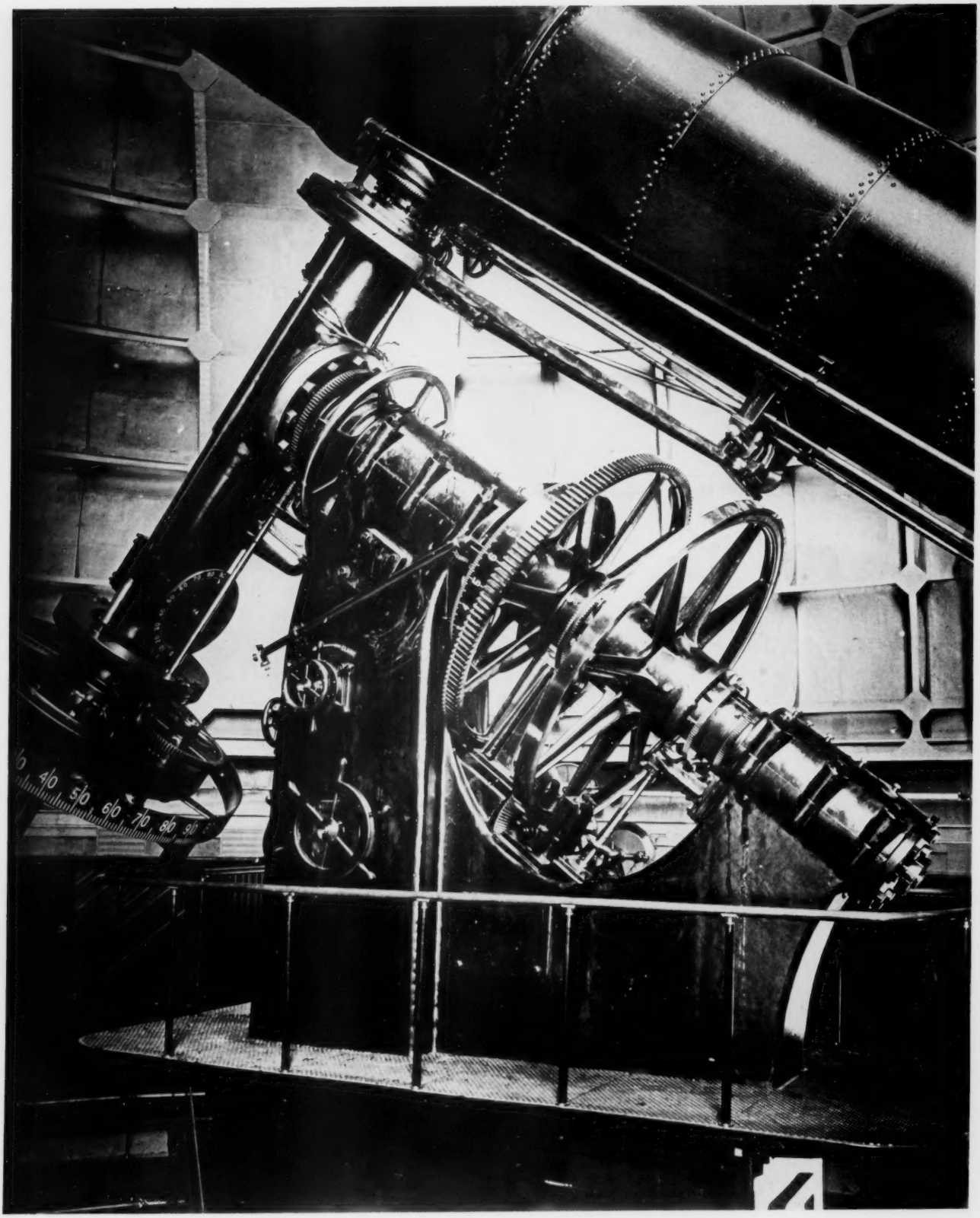

THE EQUATORIAL MOUNTING OF THE GREAT LICK TELESCOPE. **From a Photograph by Mr. E. E. Barnard.**

The central part of the tube of the great telescope is shown at the top of the picture, with its attachment to the declination axis, a steel shaft at right angles to the polar axis, which latter lies within the iron casing at the top of the pillar. The polar axis always points to the pole of the heavens, but can turn upon itself, carrying the T piece, or casing of the declination axis, with it. The telescope can turn about the declination axis so as to be pointed to all parts of the heavens. The divided circle at the left hand of the picture is the declination circle, which gives the angular distance from the equator of the heavens of the point to which the telescope is directed. The divided circle about the polar axis gives the position of the telescope in right ascension. The polar axis can be connected with a driving clock so as to counteract the diurnal motion of the earth, and keep a star in the field of the telescope.

Direct Photo Engraving Co., 9 Barnsbury Park, N.

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correspondence given by steam power, and the marvellous intelligence of the daily press, the most intimate life (so to speak) of the Crimean army was laid open to the English public from the time of its leaving these shores to the time of its return. . . . . The forces had barely landed on a foreign soil, when an uneasy consciousness that all was not as it should be began to possess the public mind. . . . . The suspicion grew with the progress of the war, gaining strength from the events at Varna, and on the beach near Eupatoria, the night after the descent upon the Crimea. The horrible deadlock at Scutari quickly followed, and doubt was at an end. With amazed indignation the British people saw an utter absence of organization in the general hospitals, department clashing with department in hopeless confusion, and official routine setting at nought the dearest interests of the soldier and honour of the country. It witnessed the wounded of Alma, of Balaclava, and of Inkerman, and the rapidly increasing sick from the camp before Sebastopol, crowded together without order or decency, and wanting even the sheerest necessaries amidst an apparent profusion of stores, and within cannon-shot of a great city. It witnessed these gallant men rotting away amidst revolting filth and neglect; the vast buildings in which they were housed converted into foul pest-houses; the medical staff helpless amidst the trammels of senseless regulations; and the military authorities deaf to remonstrance, and placidly replying to all protests that they had no official information of the state of things being such as the public press represented it to be.

"Then the indignation of the people broke forth. It intervened, with a force which could not be said nay to, between the sick and wounded and the authorities. From its abundance the nation poured out whatever was needed to give its maimed and helpless soldiers ease, comfort, and the hope of life." The *Times* organized this spontaneous outbreak of public feeling; and Florence Nightingale appeared upon the scene, and "dispelled the hideous gloom which had gathered around the sick and wounded at Scutari, and extended its shadow to every hearth in the kingdom."

To Miss Nightingale's book, "Notes on Hospitals," we owe scarcely less than to her heroic work at Scutari; but even she could have effected little but for the noble administrative work of Sidney Herbert. The reports of the Barrack and Hospital Improvement Commissioners—of whom Captain Douglas Galton is still with us as an active labourer—laid down principles which must remain true for all time, and which have been of incalculable benefit to civilians no less than to military men in many countries besides our own. It is probably no exaggeration to say that no barrack, workhouse, hospital, infirmary, asylum, or even large school has been erected in the last thirty years that is not indebted in a greater or less degree to the reports of that Commission.

In those days the duties of the army medical officers were officially confined to the treatment of the sick and wounded; as regarded preventive measures they were helpless. Before our troops sailed from England, and again in the early autumn in the Crimea, warnings were uttered by the chief medical officers, who were well versed in the medical histories of earlier campaigns, but they were curtly ordered to mind their own business. Now-a-days the main duty of the army surgeon is held to be the *preservation* of the health of the troops committed to his charge, and the Professor of Military Hygiene is not the least important teacher in the Army Medical School at Netley. English generals, now-a-days, constantly consult their principal medical officers, with the best results for all under their command.

When the pitiless Russian winter fell upon our troops it found them clothed in summer garments, with no better shelter than their bell-tents, in which the men huddled together for warmth. Crowding engendered typhus; the personal uncleanliness, scarcely avoidable under the circumstances, brought forth vermin. The lack of vegetables and delay in serving out lime-juice caused an outbreak of scurvy, and the scurvy-stricken soldiers, with spongy and bleeding gums, could scarcely gnaw the hard biscuit, their only bread. There were no definite sanitary regulations, and matters were aggravated by the men being exhausted by work in the trenches, so that we are told that the camps became "diffused cesspools"; naturally dysentery, camp-diarrhœa, and enteric fever were added to the other plagues.

The cup of misery was filled to the brim before the Royal Commissioners arrived upon the scene. The results which followed the adoption of their recommendations were startling in the extreme. "The hospitals were quickly reduced to order and efficiency, and the health of the men speedily rallied. From month to month the physical vigour of the troops improved, notwithstanding the harassing duties of the siege, and the evil sanitary condition in which, at the best, they were too frequently of necessity placed; and before the end of the war the remarkable spectacle was presented of an army maintaining a higher degree of health in the field, in presence of the enemy, than when comfortably housed in barracks at home during peace."

But who were the Commissioners? and what were their methods? They were Robert Rawlinson and Drs. Hector Gavin, John Sutherland and Gavin Milroy. They came fresh from the sanitary organization of England, under the first Public Health Act (of 1848), and they simply found a state of affairs practically indistinguishable from that prevailing in the slums of London, Liverpool, Leeds, and Glasgow, crowded as they had been by fugitives from the Irish famine of 1847. "There was the like privation, with the like results; the like unutterable filth, again with the like results; the like close packing together of the living, still with the like results; the like squalidity of person, clothing, and surroundings, again and again with the like results"—typhus, scurvy, diarrhœa, vermin.

"With the introduction of proper food, scurvy presently ceased, and with the cleansing and better ordering of the camps and hospitals, typhus, dysentery, and diarrhœa practically vanished: by the adoption, in fact, of the same sort of sanitary measures which it was sought to make common in our towns and villages at home, diseases which were at that time and still, although happily to a less extent, are the curse of our crowded communities, disappeared from the army, and the men reached the remarkable pitch of health which I have already described. And this result, it must be remembered, was brought about with the troops occupying the same positions which they had occupied since the beginning of the siege—positions around which of necessity had been deposited the accumulated filth of the occupation, and all the dead, human and brute, for which a resting-place had to be found."

It was at that time the tradition of the Navy to allow the naval surgeon more discretion in preventive measures, and it is satisfactory to be told that the naval brigade suffered much less than the soldiers; it never got into so deep a slough, and recovered it more rapidly when better times came.

But it will be asked, How about the French? Put very shortly, this is what happened. At the commencement of the operations the French troops settled down to camp

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life much better than ours; they showed a greater capacity for adapting themselves to the new conditions, although in this respect they fell short of our sailors; they were more provident in proceeding at once to make good roads from their landing-place to the front; they were conspicuously better cooks, and it is even said that they feasted upon what our men threw away. Once more, I cannot do better than quote Mr. Radcliffe's words. "Yet there was still another tragedy to be enacted in the Crimea before the war ceased. I have already spoken of the French army as suffering less than the British from the sicknesses incident to the campaign during the winter of 1854-55, and I have more than once referred to the better organization of our allies, in view of field service, at the beginning of the war. There can be little doubt that to this better organization, and to the greater adaptability for campaigning displayed by the French soldier during the first period of the war, the comparative immunity of our allies from the sufferings which crippled the British forces was owing. But after the termination of the first winter, and during the time that the British army was recovering from the state into which it had been plunged, and was proceeding step by step to that extraordinary pitch of health and efficiency I have described, the strange spectacle was presented of the French army gradually sinking into a state of misery and disease, which eventually, in the winter of 1855-56, equalled, and indeed, if it were possible, surpassed what had been witnessed in the British army the preceding winter. A more startling contrast was never contemplated than that presented by the English and French camps and the English and French hospitals during the winter of 1855-56. On the one side—the French—was to be seen a gallant army melting rapidly away from privations and from typhus, dysentery, scurvy, camp-diarrhœa, and other deadly ailments; camps degenerated to the lowest depths of negligence and filth; hospitals from which all semblance of hospital care and order had gone, and which were equally deadly to patients and attendants. As in the Crimea, so in the Bosphorus; the scenes which had been enacted in the British hospitals at Scutari in the winter of 1854-55 were now re-enacted in the French hospitals in Constantinople in the winter of 1855-56. But there the resemblance ended. With the coming of the spring of 1856 there was no arrest of the diseases which were sapping the marrow of the French army, such as there had been in the case of the British army the preceding year; and when peace was declared, the entire disablement of the French forces from privations and sickness appeared to be imminent."

Towards the close of the siege the Russians suffered also very severely from typhus, and when the army after the conclusion of the war was distributed over the country, it carried the fell plague with it to every halting-place, causing a wide-spread mortality among the civilian population, which probably far exceeded one hundred thousand.

Incidentally, a lesson in pathology (the science which treats of the nature of disease) of lasting importance was finally driven home by this campaign. Hitherto the French doctors, who at that time held a very high position in the scientific world, had been destitute of experience of typhus fever, and combated the views of Jenner, Murchison and Budd that 'continued fever' comprised at least two diseases which were fundamentally distinct, alike in symptoms, causes, and mode of propagation. The French army surgeons had ample opportunities on the plateau before Sebastopol of seeing the behaviour of the two diseases side by side, and from that time there was no disagreement as to the distinctness of typhus, which is invariably associated with overcrowding and is propagated directly from man to man, from typhoid or enteric fever, which is associated with conditions of excremental filth and propagated for the most part indirectly by means of polluted water or milk.

True sanitary method necessitates a foundation of exact knowledge of the nature of disease.

Mr. Radcliffe adds with great force: "If it had been possible for any doubt to have rested upon this great result and its causes, the spectacle of the French army sinking into the slough out of which we had escaped, and the conditions under which this happened, would have put an end to it. Here, then, was a lesson in hygiene, having the precision and force of a scientific experiment, as applicable to civil as to military life, and which exercised a less obvious but hardly less important part on the progress of civil hygiene in this country than it did upon military hygiene."

THE THERMAL RADIATION FROM SUNSPOTS.

By W. E. Wilson, M.R.I.A.

Communicated to the Royal Society, January 4th, 1894.

THESE observations were made by means of a large heliostat, lent by the Royal Society, and a Boys' radio-micrometer. The heliostat consists of a plane silver on glass mirror of 15 in. aperture. It is mounted equatorially, and driven by a clock. When in use, it is adjusted to reflect the sunlight to the north pole, and as long as the driving clock is kept in motion the beam of light remains fixed in that position. In the track of this beam, and about 12 ft. from the plane mirror, is mounted a concave silver on glass mirror of 9 in. aperture, and about 13 ft. focus. Its axis points to the south pole, so that the cone of rays formed by it strikes the centre of the plane mirror at a short distance inside the focus. A small plane mirror mounted on the end of an arm is then so placed as to intercept the cone of rays, and reflect it horizontally into the observatory window; an achromatic lens enlarges the solar image which is formed on a screen in the room to 4 ft. in diameter.

Behind this screen, and standing on a pier of concrete, is mounted the radio-micrometer. The aperture through which radiant heat reaches the sensitive thermo-couple is a round hole drilled through a thick sheet of brass, and is only 1 mm. in diameter. A white cardboard screen is placed in front of the brass one to cut off heat from falling on the latter, and is provided with a hole slightly larger. A beam of lime-light is thrown on the mirror of the radio-micrometer, and reflected on to the scale in the usual way. The diagonal mirror of the heliostat is provided with slow motions in two directions, which are moved by long rods and hook joints inside the observatory. Thus any part of the sun's disc can be placed on the small aperture of the radio-micrometer, and the driving clock will then keep it there.

The observations are taken in the following manner. A small screen is placed over the aperture of the radio-micrometer, and the zero position of the spot of light on the scale noted. The screen is then removed, and the umbra of a sunspot placed on the aperture. The reading is then taken and entered in column *u*. The image is then moved, so that a part in the neighbourhood of the spot, but at *the same distance from the centre of the solar disc*, is placed on the aperture. This reading is entered in column N. Finally, a reading is taken at the centre of

the disc, and entered in column C. The throws of the instrument are then got by subtracting the figures in columns *u*, N, and C from the zero. The deflections of the instrument have been experimentally proved to be *strictly proportional* to the amount of radiant heat falling on the thermo-couple. The following is a typical observation taken August 7th, 1893, of a large sunspot then visible. The *umbra* of this spot measured 0·8 in. across on the screen, so that the aperture of the radio-micrometer was only covering about $\frac{1}{400}$th of that of the umbra.

Zero.	*u*.	N.	*u*−*z*.	N−*z*.
15·8	17·1	20·4	1·3	4·6
15·6	16·9	20·2	1·3	4·6
15·5	16·8	19·9	1·3	4·4
15·3	16·7	19·8	1·4	4·5
15·2	16·6	19·6	1·4	4·4
15·1	16·4	19·5	1·3	4·4
14·9	16·1	19·4	1·2	4·5
		Means.....	1·31	4·49

$$\text{The ratio} \frac{\text{umbra of spot}}{\text{neighbouring photosphere}} = \frac{1{\cdot}31}{4{\cdot}49} = 0{\cdot}292.$$

Five concordant readings gave a mean deflection of 4·57 for the centre of the sun, which gives for the ratio $\frac{\text{umbra}}{\text{centre}} = 0{\cdot}287$.

This spot was at a distance from the centre of the disc of about 0·4.

As the radiation from the photosphere falls off from the centre to the edge of the disc, it seemed an interesting point to determine if any change in the ratio of *u*/C would take place as a spot was carried across the disc by the sun's rotation. If the spot is, as has been generally thought, a depression, the absorption of heat ought to increase as it is carried towards the limb, on account of the increased depth in the solar atmosphere through which the radiation would have to pass. On the other hand, if the spot was floating *above* the absorbing atmosphere the radiation from it would remain constant in any position on the solar disc.

The following is the value of the heat radiation from the photosphere taken along a radius of the sun, where 0 = centre and 100 is the distance of the centre from the limb. The radiation R equals 100 at the centre.*

D.	R.	D.	R.
0...	100·0	70...	87·8
10...	99·8	75...	85·3
20...	99·5	80...	82·5
25...	99·3	90...	72·0
30...	98·9	95...	61·8
40...	97·2	98...	51·5
50...	95·3	100...	42·9
60...	92·2		

It will be seen by the following observations of spots, taken from August 5th to November 9th, that there is distinct evidence that the radiation from the spot does not fall off as rapidly when near the limb as the radiation from the neighbouring photosphere; in fact, the ratio *u*/C remains nearly constant, whereas the ratio *u*/N gets nearer unity as the spot approaches the limb. The spot observed on October 22nd is a good example, as the same spot was observed again on the 26th, 29th, and on the 30th, when it had reached within a distance, D, of 95 from the centre. It will be seen that on these four dates the ratio *u*/C was respectively 0·338, 0·360, 0·313, 0·356, whereas the ratio *u*/N was 0·349, 0·410, 0·706, 0·783.

Date.	$\frac{u}{C}$	$\frac{u}{N}$	D.
1893.			
Aug. 5	0·370	0·427	60
7	0·287	0·292	40
8	0·286	0·323	50
8	0·339	0·377	40
8	0·418	0·512	90
14	0·364	0·373	50
19	0·368	0·375	50
Sept. 2	0·309	0·309	10
3	0·298	0·298	10
4	0·420	0·450	30
4	0·430	0·446	30
7	0·287	0·355	85
Oct. 1	0·398	0·401	30
1	0·489	0·570	80
22	0·338	0·349	52
26	0·360	0·410	40
29	0·313	0·706	90
30	0·356	0·783	95
Nov. 8	0·365	0·800	97
9	0·339	0·848	85

Langley,† in 1874 and 1875, measured the radiation from the sun and the radiation from spots. He used a thermo-pile and galvanometer, and obtained as the mean of his results a ratio of 0·54±0·05.

His method was first to take a reading in the neighbourhood of the spot, but between it and the centre of the disc. He then took a reading in the umbra, and, finally, a third reading in the neighbourhood between the spot and the edge of the sun.

The mean of the two photospheric readings he used as a divisor for the umbral reading. He then says, "The decrement of heat as we approach the limb is, though not exactly, yet so very nearly, in the same ratio for photosphere and spots, that no correction is needed on this account for the present observations."

If Langley failed, through want of instrumental means, to notice the difference between the absorption in a spot and the photosphere near the limb, his method would make his umbral readings too high. The mean of twenty observations here equals 0·356, against Langley's 0·54. This is a serious difference, and, I think, can only be accounted for either by the use of superior instrumental means, or by a possible variation in the radiation of spots in different years of the sunspot cycle.

It is difficult to see how *too low* a value for umbral radiation could be got, whereas too high a one might be found by want of definition and trembling in the image, so that some of the penumbral radiation would reach the thermo-couple.

THE NORTH POLE OF THE MOON.

By A. C. Ranyard.

WHATEVER may be the temperature of the equatorial regions of the moon, it will not be disputed that the moon's polar regions must be exceedingly cold, for no clouds float above the moon's surface, and many phenomena go to prove that if the moon has an atmosphere it must be a very thin and scanty one compared with our own, so that such an atmosphere would afford but a poor covering to

* "The Absorption of Heat in the Solar Atmosphere," by W. E. Wilson and A. A. Rambaut, *Proceedings of the Royal Irish Academy*. 3rd series, Vol. II., No. 2.

† *Monthly Notices*, Vol. XXXVII., No. 1.

prevent the radiation of heat from the body of the moon. Added to this, the poles of the moon never advance as far into the sunlit lunar hemisphere as the poles of the earth advance into the earth's sun-lit hemisphere.

It will be remembered that the earth's poles enjoy a period of six months of continuous sunshine, during which they advance into the sun-illuminated hemisphere to a distance of more than twenty-three degrees from the zone of sunset tints which continually encircle the earth, dividing the sunlit half from the starlit half.* But the moon's poles never advance as much as one and a half degrees into the sun-lit hemisphere, for the lunar equator makes an angle of only 1° 28′ 45″ with the ecliptic. The north and south poles of the moon are consequently never very far from the terminator or zone of sunrise and sunset on the moon.

Our plate illustrates very well the sort of illumination which objects near to the lunar terminator enjoy. The steep sides of the lunar mountains are brightly lit up, but the valleys and hollows and the lunar plains are left in darkness, or are only faintly illuminated by very slanting rays. A region constantly within a degree and a half of the terminator would therefore receive very little heat, though it would radiate as freely as any other part of the moon, and we should expect to find it relatively colder as compared with the lunar equator than the earth's polar regions are compared with our equatorial regions. Judging by analogy, therefore, if there is any water-vapour in the lunar atmosphere, we should expect to find it condensed in greater quantities in the lunar polar regions than in regions with a higher average temperature, but there are no distinguishing white caps to mark the place of the lunar poles, and we must conclude, either that the lunar poles are not covered with snow, or that the polar snow-caps extend as far as the lunar equator, and that the only difference between the equatorial and polar regions is that the layer of condensable vapour is thicker at the poles than in the neighbourhood of the lunar equator.

There is some evidence which tends to show that there is some kind of condensable vapour in the lunar atmosphere, for the mountainous regions and higher parts of the moon's surface are always whiter than the low-lying land. This is well illustrated by the beautiful lunar photograph of the Brothers Henry, reproduced in our plate. The limb or sharp edge of the moon is shown in it (as well as in all other good photographs of the lunar crescent) as very white, distinctly whiter than the lunar surface at a little distance from the limb. At the limb we are looking tangentially at the lunar surface, and only the tops of the lunar mountains and high ground would be visible to us. valleys and low-lying land being eclipsed by nearer regions at a higher level. But the smooth limb of the moon is always whiter than other parts of the disc, whether the moon is gibbous or presents a thin crescent form. In the crescent phase shown in our plate we are looking at the shadow side of the mountains on the limb, and not at the slope which lies in the full glare of sunlight. It might be argued that the white band along the limb of the gibbous moon is due to the fact that we are looking at the sun-illuminated sides of the mountains on the limb, and that these appear relatively bright as compared with less vertically illuminated surfaces. The relative brightness of objects near the terminator (or region of lunar sunrise) evidently very materially depends on the slope which they present to the slanting rays of the sun; but as the sun rises and the shadows grow shorter, the slope of the surface makes less and less difference, until at the full moon, when no lunar shadows can be seen from the earth, the differences of brightness of different parts of the lunar surface must be due to actual differences in the albedo or light-reflecting power of the lunar surface. In the case of the mountains and cliffs seen along the limb of the crescent moon, the slope of the surfaces seen from the earth is away from the direction in which the sun's rays are falling, and any appearance of greater whiteness must be entirely due to the actual whiteness or light-reflecting power of the mountains.

We consequently have in this band of whiteness along the lunar limb very forcible evidence that the lunar mountain tops are white as compared with the average whiteness of the lunar surface. The whiteness, and consequent brightness, of this band along the limb is so considerable that in lunar photographs it is the first part to become over-exposed, and it then hides the irregularities of the limb, which are well shown in the comparatively under-exposed photograph of the Brothers Henry reproduced in our plate.

The white material which condenses on the lunar mountain tops need not necessarily be snow. Any vapour which condenses in small transparent crystals would look snow-like and white, on account of the way in which such crystals break up the light. Thus, the feathery crystals formed from carbonic acid vapour, in the well-known lecture experiment, look snow-like and white, and probably crystals of frozen air would have a similarly snow-like appearance.

But if we accept the concurrent testimony of Profs. Langley and Very, the Earl of Rosse, and Prof. Boys, the temperature of the surface of the equatorial regions of the moon during sunshine is not very far from 0° Centigrade, or the freezing point of water. At such a temperature, crystals of carbonic acid or of atmospheric air would evaporate with extreme rapidity; and it is not conceivable that such rapid evaporation could go on during the fortnight of the lunar day without giving rise to a gaseous envelope about the moon, which would be easily detectable by the distortion of the sun's image during a solar eclipse, and by the phenomena observable during the occultation of stars at the moon's limb. For there is no recognizable change of whiteness from sunrise to sunset at the lunar equator—that is, the white covering is not entirely evaporated away, and the continuity of colouring from the moon's poles to its equatorial regions shows us that if there is any polar capping of condensable vapour, the polar white caps extend from the pole to the equator, and that they are not even materially diminished in extent in the lunar equatorial regions during the fortnight of unclouded sunshine passed through in every lunation.

We have therefore to choose between two alternatives: either the general whiteness of the moon is caused by an extensive snow-like covering, which is not evaporated away in the lunar equatorial regions during a fortnight of temperature not far removed from the freezing point of water, or the moon's whiteness is due to the natural colour of its surface rocks, and we are then forced to assume that all the lunar mountain tops are formed of white rocks, while the plains and low-lying areas are formed of a darker material. The latter assumption will not be seriously maintained by anyone who considers the great disturbances

* The zone of sunset tints glides over the earth always touching two parallels of latitude. At midwinter and midsummer it lies between two small circles, with a radius of about twenty-four degrees described about the northern and southern pole. It is never a "great circle," but always lies a little within the dark hemisphere, for the sun in setting is raised by the refraction of the earth's atmosphere more than half a degree. A little before the autumn equinox and a little after the spring equinox it passes through the poles, and then as seen from the outside would appear to spin round the parts of the zone where the tints of morning and evening meet.

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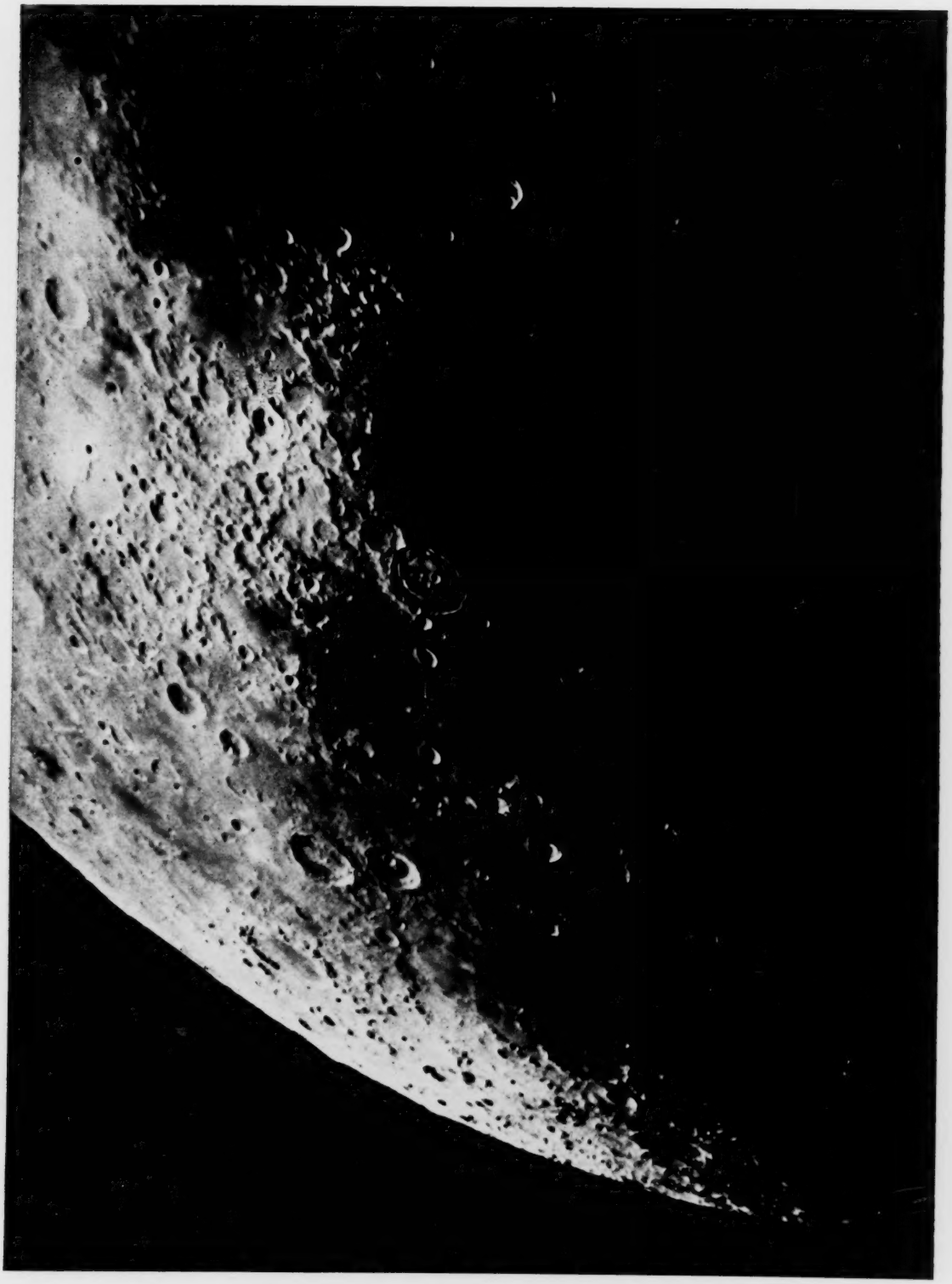

THE NORTH POLE OF THE MOON.

From a photograph taken by MM. PAUL and PROSPER HENRY at the Paris Observatory.

Direct Photo Co., 9, Barnsbury Park, N.

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to which the lunar crust has been subjected. If there had originally been such a bridecake-like stratification, it must long ago have been disturbed by the action of the forces which have built up and levelled again gigantic lunar craters and mountain chains.

The steep precipitous cliffs and tall pinnacles of rock which are to be seen on so many parts of the moon are standing evidence that the moon has a gaseous envelope around it sufficiently dense to protect such rocky pinnacles from being levelled by meteoric bombardment, for the moon must encounter as many meteoric particles in its annual journey round the sun as a similar area of the earth's atmosphere encounters. But not a millionth per cent. of the meteoric bodies encountered by the earth's atmosphere reach the earth's surface ; they are, in nearly every case, entirely driven into vapour before they reach a height of fifty miles above the earth's surface. If the lower hundred miles of the earth's atmosphere were condensed or done away with, it is evident that the earth would be subjected to a very serious bombardment, for even a particle as large as a mustard seed, projected with a velocity of eighteen miles a second against a cliff face, would bring down a portion of rock much larger than itself, probably shattering the rock for a considerable distance round the place of impact ; for we know that the force of a blow increases proportionally to the square of the velocity of the projectile, and the damage done by meteors meeting the earth with a motion in a contrary direction to the earth's motion round the sun would be even more considerable.

Such considerations seem to render it probable that the moon has an atmosphere of some sort which acts as a protecting shield, or otherwise, in the course of geologic ages, cliffs and pinnacles would have been shattered, and they could not have retained their precipitous forms.

Most of the meteors which we see consumed in our atmosphere become visible at a height of less than one hundred miles, and they are generally entirely driven into vapour before they reach a height of fifty miles above the sea level. Such an atmosphere as surrounds the earth at a height of fifty miles above the sea level would consequently be sufficiently dense to enable the moon to preserve the sharp outlines of its geologic features. If we assume that the earth's atmosphere continues to halve in density with every increase of three and a half miles by which we rise above the earth, the density of our atmosphere at a height of fifty miles would be about one fifteen thousandth part of the density at the sea level.

The observations with regard to lunar occultations and solar eclipses, referred to above, enable us to say that the moon certainly is not surrounded by an atmosphere of similar material to our own, which is one two-thousandth part as dense as the earth's atmosphere at the sea level.

But it may very possibly be surrounded by an atmosphere which is one ten-thousandth part as dense. Assuming that it is surrounded by such an atmosphere, the absence of white caps about the lunar poles would seem to show that the cold, even in the polar regions, is not sufficiently intense to freeze the lunar atmosphere. If the lunar air is similar in chemical composition to our own, this would enable us to affirm that the temperature of the lunar poles has not yet fallen below about −180° Centigrade. It is evident that at some period, the geologic record of which is not yet effaced, there were considerable volcanic displays at the lunar poles, for both the northern and southern lunar polar regions are thickly crowded with crater rings—indeed, the volcanic activity at the lunar poles seems to have been greater than in the lunar equatorial regions.

Science Notes.

Prof. Dewar, in a recent lecture at the Royal Institution on the scientific use of liquid air, and the study of the properties of matter under very low temperatures, demonstrated that in low temperatures the tensile strain of metals is stronger, and their colour also is less brilliant.

Some interesting details have been published in the *Transactions of the Texas Academy of Science*, concerning rain-making and the rain-makers. For the problem of overcoming the severe drought in such districts as the United States, or New South Wales, has, at irregularly recurring intervals, engaged the attention both of men of science and various impostors, who have endeavoured to persuade the Government to make trial of their schemes. The problem that has to be solved is the cooling of the upper layers of the air to such an extent that some of the moisture contained in it shall be precipitated. One of the theories on which several rain-makers based their suggestions was that if a rapidly ascending current of air could be produced, on reaching a great height this would expand under the conditions of diminished pressure, and in expanding would cool, and so precipitate some of its moisture. But the production of this ascending current is in itself the first difficulty. The scheme that Prof. Espy proposed in 1837 was to kindle great fires, thus producing a rising current of hot air. It would be better for the success of the scheme if the air could be induced to rise before first heating it, as the object of the theorists is to produce cooling in the upper strata.

It is a well-known fact that a shock of some kind given to a supersaturated atmosphere will sometimes precipitate the excess of moisture held in suspension, and it seems to be some distortion of this fact that has actuated some of the schemes of the rain-makers ; for they appear to have thought that a severe shaking was all that was necessary to induce the atmosphere to render up its aqueous vapour. Mr. Powers, of Wisconsin, published in 1870 an ingenious collection of random statistics entitled "War and the Weather," in which he endeavoured to prove that battles were followed by heavy rainfall. The same idea moved another rain-maker, and having obtained a Government grant of a considerable sum, he proceeded to make war upon the elements in true military style. Ground explosives were fired off at some advancing rain-clouds, then balloons, charged with explosives, were fired inside them, shells were projected at them, but the clouds sailed away in unruffled serenity, regardless of the rain-maker and his challenge.

A more scientific scheme was afterwards patented, which consisted in freeing liquefied carbonic acid in the air ; this liquid, by rapid vaporization, producing great cold. But as a frequent expedient, this plan is marred by the fact that the cost of one inch of rainfall over a square mile would be four hundred thousand dollars.

Some curious mechanical devices have been seriously proposed for rain-making, such as Mr. Pitkin's large sheet of canvas, which was to be hung in the air with the object of deflecting upwards warm air currents into a colder strata. Mr. Astor's invention is a tower, up which air is to be pumped by an engine, such a tower having presumably to be about the height of the Eiffel tower, and therefore similar in cost. The engine too would probably require much more water than the whole apparatus would conjure out of the atmosphere.

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Notices of Books.

Celestial Objects for Common Telescopes. By the Rev. T. W. Webb. Fifth Edition, revised and greatly enlarged, by the Rev. T. E. Espin. Vol. I. (Longmans, Green & Co.) This is a new edition of a book which has probably made more astronomical observers than any other book that has been published. It is fourteen years since the fourth edition appeared, and nine years since Mr. Webb's much-lamented death; and considering the rapid advances which have been made in every branch of observational astronomy during the past decade, a new and enlarged edition of the Celestial Objects was much needed. The astronomical public owe a debt of gratitude to Mr. Espin for the trouble and care he has spent upon its production. The bulk of the book has been considerably increased. It will now be issued in two volumes, only the first of which has as yet appeared. The first volume contains an appreciative little memoir of Mr. Webb by his friend and executor Mr. Espin, which is followed by Mr. Webb's chapter on the use of the telescope, to which notes on celestial photography and the use of the spectroscope have been added; and the old chapters by Mr. Webb on the sun, the moon, the planets, comets and meteors, to which more or less extensive notes have been added by Miss Brown, Mr. Elger, Mr. Stanley Williams, Mr. Waugh, Mr. Freeman, and, last but not least, Mr. Denning. The second volume refers to double stars, clusters, and nebulæ, and to its enlargement and bringing up to date Mr. Espin has especially given his attention, greatly adding to its value by his additions.

The Theory of Heat. By Thomas Preston, M.A. (Dublin). (Macmillan & Co., 1894)—This is a companion volume to Professor Preston's admirable book, "The Theory of Light," published four years ago. It is a still larger volume, extending to over 700 pages, and embraces a wider range of subjects, which Professor Preston endeavours to deal with historically as well as theoretically. No scientific inquiry is more full of human interest than the study of the nature of heat, for no branch of science is, as Professor Preston remarks, so intimately connected with the every-day occupations of life. Professor Preston is a lucid exponent of the theoretical parts of his subject, and an interesting writer, who gives a living interest to every subject he touches. All the chapters are methodically arranged and broken into convenient paragraphs. He gives, wherever possible, the classical experiments which have led to the discovery of new facts and important advances in theory, and leads the reader to take a personal interest in the work of Lavoisier, Rumford, Pictet, Herschel, Dalton, Davy, and Gay-Lussac. His chapters on the early theories of Heat, on Matter, and on Energy, with which the book commences, are particularly to be recommended.

Life and Rock; a Collection of Zoological and Geological Essays. By R. Lydekker, B.A. (Cantab.), F.G.S., F.Z.S. London: The Universal Press, 326, High Holborn. 1894.—Our readers will be glad to see this collection of essays, many of which they will remember in the pages of Knowledge, though they are now in a slightly altered form, having been carefully revised, and in some cases further illustrated by the author. Mr. Lydekker's articles are always interesting and instructive; probably no other palæontological writer deals with the problems of evolution and development in so attractive a manner; he has the gift of putting before his readers multifarious facts and details about dry bones in a way that makes them see the living animal, and follow with interest the logical conclusions to which he desires to lead them.

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

A BLACK AURORA.

To the Editor of Knowledge.

Sir,—The appearance of the great sunspot which was visible from February 20th till the beginning of March lends interest to a curious meteor seen by me on January 25th last, about 8 p.m., at Croydon. It consisted of five dark rays or streamers, which emanated from a point over the northern horizon at or near the true north, and radiated like the spokes of a wheel towards the zenith, or it might be the magnetic zenith. The rays were clearly defined against a hazy sky, which was faintly illuminated by the glare of the metropolis, and resembled five blades of a black outstretched fan. As I looked, the whole system wheeled slowly through an arc of 30° or 40° towards the east, and then faded out. The rays did not seem to quiver or change colour, but remained black or smoky, and reminded me of streaks made by a hair pencil dipped in Chinese ink. I regard the phenomenon as a black aurora, because of its behaviour and the collateral phenomena. Black or smoky pillars and patches have been observed in auroras, but although I have examined the records of hundreds of displays, I have seen no account of a similar effect.

I may add that on the evening of February 28th, about 8 p.m., an aurora was seen in Croydon by me and many others. Two white luminous patches, one waxing while the other waned, appeared in the clouded sky near the Great Bear, and several more near the constellation Orion. A dirty greenish arch of diffused light over a dark segment also showed above the northern horizon, and gradually spread up the sky nearer to the zenith. The display lasted an hour or more, and was also seen with better effect in other parts of the country, where red streamers emanated from the greenish arch. As the black aurora seems to have heralded the sunspot, and the green display to have followed it, perhaps you will consider these observations of some interest.

Croydon. Yours, J. Munro.

[If we suppose with Mr. Munro that the dark rays radiating "from a point over the northern horizon" were sufficiently opaque to cut out the light reflected by the atmosphere from the gas lamps of London, we must assume that they were foggy semi-opaque regions in the lower atmosphere, an assumption which entails a considerable strain on the imagination, especially when we remember that the haze-producing particles which reflect the glare from a town probably float at no great height above the ground.

It seems to me easier to assume that the dark rays were narrow interspaces between broad bright rays. Readers of Mr. Munro's book, "The Romance of Electricity," will congratulate him upon his good fortune in witnessing so curious and interesting a phenomenon.—A. C. Ranyard.]

To the Editor of Knowledge.

Beechfield, Heswall, Cheshire,
19th March, 1894.

Dear Sir,—On the 15th of March last, from 6.30 to 7 p.m., I observed what, to me at all events, was an unusual appearance, as the sun rose over the lunar crater Clavius.

The ridges of the two principal inner craters, being illuminated, showed a brilliant red colour in very marked contrast to the general surface of the moon. The colour

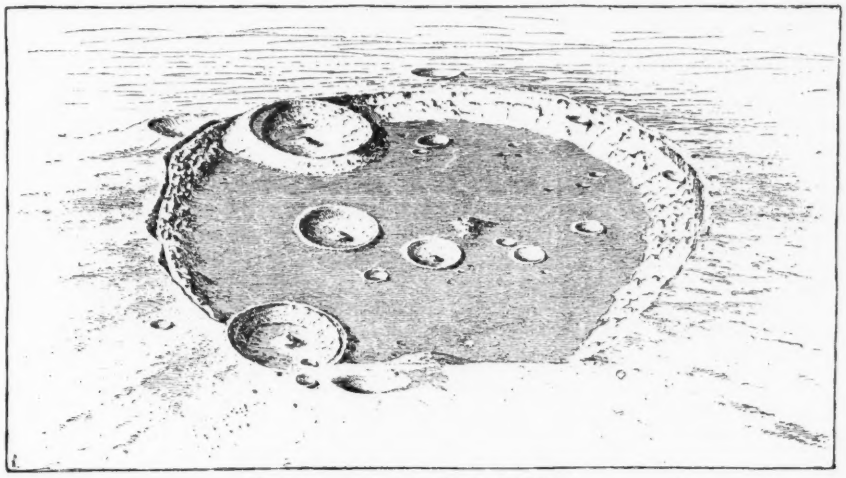
was of precisely that hue with which we are familiar in our terrestrial morning and evening skies, and prompts me to ask the question whether it is a phenomenon often observed in regard to sunrising on the moon, and whether or not it may be held to be evidence of a lunar atmosphere possessing a certain amount of absorptive power similar to that of our own air.

I may say that, not being familiar with such an appearance, I at once attributed it to instrumental dispersion, and took considerable pains to ascertain whether the colour could arise from such a source, but, after trying several powers both upon Clavius and other parts of the moon, I was unable to connect the colour with any such cause; and whether the eye-piece was in proper focus or not, the red colour still remained conspicuous in the imperfect image so produced.

The atmospheric conditions, I might add, on that occasion were, from the unusual amount of detail and steadiness perceptible, apparently better suited for observation of the moon than it has usually been my fortune to find.

I am, Sir, yours truly,

Charles MacIver.



Clavius, from a drawing by G. K. Gilbert.

[I am unable to suggest any optical illusion which would account for Mr. MacIver's observation. He seems to have taken ample precautions to test whether the brilliant red colour was due to the eye-piece used.

Sunrise upon Clavius is a magnificent spectacle, which has been watched with wonder and delight by many generations of astronomers; Beer and Mädler, Webb and Neison, all speak of it with enthusiasm. At first the sun lights up the western wall of the great crater, which is one hundred and forty-two miles in diameter. As the sun rises it presents the appearance of a great bay of darkness penetrating into the illuminated portion of the moon; then some small bright points appear in the bay—these are the summits of the rings of craterlets on the floor of the great crater; as the sun continues to rise, the craterlets appear as bright rings, like golden atolls in a sea of ink; at last the sunlight reaches the floor of the great crater, and the long shadow of the western wall of the crater slowly recedes till the whole of the crater floor is lit up.

Mr. MacIver's observation seems to have been made at the time when the sun's light had reached the ridges of the inner craters; they then appear as intensely brilliant rings on a dark background, and any chromatic defect of the telescope would be more recognizable upon them than on a bright object upon a bright background. Sunset and sunrise tints are certainly not generally recognizable upon the moon's terminator, and it is doubtful whether there are any half-tints, or region of crepusculum, such as would probably be seen upon the earth in the regions of sunset and dawn. The parts of the moon just beyond the parts lit up by the first rays of the rising sun would be illuminated by the light of the corona and chromosphere, but I have not been able to trace any coronal or chromospheric lines in the light from the dark region just beyond the terminator when examined with a spectroscope. M. Thollon and Mr. Lockyer have similarly searched for evidence of coronal light at the lunar terminator, but have failed to find it. It seems, therefore, improbable that the ruddy tints observed by Mr. MacIver could have been due to illumination by the red light of the chromosphere. If the little craters shone with a red-hot glare we should expect to see them glowing on the dark side of the moon before the lunar sunrise, and possibly retaining their red colour after the sun had risen.

The only suggestion that occurs to me is that Mr. MacIver's eyes may be very sensitive to strong light, and that he sees coloured images for some time after looking at a bright object. The brighter parts of the moon are very dazzling when looked at in the telescope without a dark wedge to subdue their light, and they are relatively very bright compared with objects on the lunar terminator.—A. C. Ranyard.]

To the Editor of Knowledge.

Sir,—Mr. Lynn on page 7 calls 1899 the "last year of the present century." I should call it the last but one. The comet due therein, he says, has "only hitherto been seen in the winter of 1865." But I submit it was seen in the summer of 1366, and recorded so that its perihelion has been reckoned the 21st of October, or four hundred and ninety-nine years seventy-two days before the last perihelion. This divided by fifteen gives 33·281, instead of the 33·18 of Oppolzer's reckoning from 1866 only. Apart from all perturbations by Jupiter and Saturn, we might therefore expect it early in May, 1899. That is the least likely time of year for it to be seen, we being on the opposite side of the sun. The effects of Jupiter and Saturn seem eminently worth computing in this case.

Yours truly,

E. L. Garbett.

[Mr. Garbett is obviously right about the year 1899 not being the last year of this century; but it is a common oversight, into which I inadvertently fell. No great reliance can be placed on an orbit determined from observations made in 1366, whilst Le Verrier's theory that the Leonid meteors were introduced into our system by Uranus cannot be proved, though it remains probable that their introduction took place at a comparatively recent date. Neither their period, nor that of the small comet which moves in nearly the same orbit, is known very exactly.

That the comet is identical with the one recorded in the Chinese annals five centuries before is exceedingly doubtful; a glance at the elements of the orbit of the latter as computed by Peirce will at once show how uncertain they are, as is remarked by Mr. Hind in his "Comets." Oppolzer's determination of the orbit of the comet of 1866 is probably as accurate as could be made from observations which extended over an interval of less than a month. To compute its perturbations with much accuracy would not be a very hopeful task at present; after the return in 1899 (which will probably take place in March) this will be more practicable.—W. T. Lynn.]

WEIGHING THE EARTH.

By J. J. Stewart, B.A., B.Sc.

(*Continued from page* 32.)

THE method adopted by Prof. Poynting in his earth-weighing experiments, concluded a year or two ago, is a modification of that of Cavendish, in which the balance is directly made use of, and the force of attraction due to a sphere is found by placing it beneath a scale pan, and then balancing the disturbance of the beam produced by the sphere in this position, by adding weights to the other pan.

"In using the common balance to find the attraction between two masses, perhaps the most direct mode of proceeding would consist in suspending a mass from one arm of a balance by a long wire, and counterpoising it in the other pan. Then bringing under it a known mass, its weight would be slightly increased by the attraction of this mass. The increase would be the quantity sought if the attracting mass had no appreciable influence before its introduction beneath the hanging mass, and if, when beneath it, the effect on the balance could be neglected. This is very nearly the principle of the method used by Von Jolly."

Prof. Poynting used a differential method. A spherical mass was placed first under one of two masses suspended from the beam of a balance, and then placed under the other, the tilt produced in the beam being observed. Then the suspended masses were raised to a higher position, and the attracting mass placed under each alternately as before; in this last case the attraction on the beam is the same as in the first experiment, and this attraction can thus be eliminated, for the difference between the two observations of the increase of weight on one side is caused solely by the alteration of the positions of the suspended masses with reference to the attracting sphere below them; the attraction on the beam remains the same in each case. From the observed effect of a known alteration of distance, the attraction at any distance can be arrived at.

The attracting mass used in the experiments consisted of a metallic sphere. This was placed on a turntable, and could thus be gently moved into its position below the balance or away from it. The experiments were commenced at the Cavendish Laboratory, Cambridge, in a room in the basement. The apparatus was afterwards moved to Birmingham, and the experiments continued at the Mason College there. The balance room was in the basement of the building, and observations were taken by a telescope placed in the room above through an opening in the floor. The balance used was of the large bullion balance type, and was made specially for the experiment with extra rigidity of beam. The movement of the pointer of the balance was shown by reflection from a suspended mirror. Both the attracting and attracted masses were made of an alloy of lead and antimony for the sake of hardness, and their surface was gilded.

Errors were detected due to alteration of the slope of the floor on moving the weight. There was also a slow gradual change. Another mass, half as great as the attracting mass, was placed on the opposite side of the turntable and twice as far from the axis. This arrangement caused the resultant pressure to be always through the axis. A second set of experiments was made with the masses turned over, to get rid of any error which might arise owing to want of symmetry, the mean of the two sets of experiments being taken.

Errors due to air currents were the most difficult to get rid of. In warm, quiet weather the air was steadiest. Prof. Poynting says the opening or shutting of a door anywhere in the building had a visible, though transient, effect on his apparatus, doubtless through the production of an air wave. In a high wind the balance was always unsteady, partly owing to rushes of air into and out of the case with sudden changes of pressure, and partly through changes of ground level with variations of wind pressure against the building.

The law of universal gravitation states that when two masses m m^1 attract each other the attraction is $\frac{K\ m\ m^1}{d^2}$, K being the gravitation constant, which is the same for all masses, and d the distance between the masses.

When the gravitation constant K is known, the mean density Δ of the earth can be found immediately; for if V = volume of the earth considered to be a sphere of radius R, the weight of any mass, M^1 being the attraction of the earth upon it, is $\frac{K\ V\ \Delta\ M^1}{R^2}$; but if g denotes the acceleration produced by gravity the mass is also $= M^1\ g$. Therefore $\Delta = \frac{g\ R^2}{K\ V}$.

Prof. Poynting finds as the mean value of Δ from his experiments 5·493. In one set of his experiments the value found was less than that got by Cavendish, in another set it was greater, the mean being as above.

It has been suggested that a good way of finding the earth's mass would be to observe the change of deflection produced in the plumb line by the filling and emptying of an estuary by the periodic movements of the tides. The quantity of matter occupying the space of the estuary or arm of the sea would undergo regular periodic changes, and by observations of the changes of latitude every six hours a good determination of the constant required might be obtained.

A method very similar to this, and of a very interesting character, has quite recently been employed by M. Alphonse Berget, who described his experiments in the *Comptes rendus* of the Paris Academy of Sciences last year.

The experiments consisted in artificially causing a change of level in the waters of a lake. The level was raised or lowered through a distance of a little over three feet, and the effect of this alteration on a hydrogen gravimeter, such as that which was employed to measure the diurnal variation in gravity, was observed. The lake on which these trials were made is in Luxemburg, and has an area of seventy-nine acres. Its level could be raised or lowered by the above-mentioned amount in a few hours, and the variation in the column of mercury of the observing instrument was determined by a very delicate method, which consisted in noting the appearances and changes in Fizeau's interference fringes, formed *in vacuo* between the

surface of the mercury and a flat sheet of polished glass placed at the bottom of the observing tube. Two sets of readings were taken, the one on lowering the level of the lake by about twenty inches and forty inches, the other on raising the level through the same distances. The results obtained are given in centimetres; the displacement of the columns for a change of level in the water of one metre was ·0000000126 centimetres. From this the gravitation constant, K, *i.e.* the attractive force in dynes produced by a mass of one gramme upon another equal mass placed one centimetre from it in air was found to be $6{\cdot}80 \times 10^{-8}$, *i.e.* ·000000068 dynes. The mass of the earth was found to be $5{\cdot}85 \times 10^{27}$ grammes, and its density 5·41, which differs but little from previous results.

The numbers above are deduced thus:—Put in the value of $K = 6{\cdot}80 \times 10^{-8}$ in the formula $g\,\mu = K.\frac{\mu M}{R^2}$, in which M = mass of the earth in grammes.

R = radius of the earth in centimetres = $6{\cdot}37 \times 10^8$.

g = intensity of gravity = 981.

Hence M is found to be $5{\cdot}85 \times 10^{27}$ grammes, and the value of the density follows at once as 5·41 compared with water.

Another determination of the density has in recent years been carried out by Von Sterneck at Freiberg. These experiments were made in the years 1882 to 1885 and were similar in character to the pendulum experiments of Airy. The times of swing of the pendulums at the surface and at a depth within the earth were obtained by observing the coincidences with the same clock, which gave electrically, at the same instant, half-second signals at the two stations. The results, however, tend to confirm the opinion that the pit method is not a suitable one for determining the mean density of the earth, though it may throw light on the composition of the strata near the surface.

In conclusion, the different values found for the density of the earth in the principal experiments made for determining it may be given.

Plumb line at Schiehallien (Maskelyne and Playfair)	4·713
,, at Arthur's Seat (James)	5·316
Pendulum at Mont Cenis (Carlini and Giulio) ...	4·94
,, at Harton Coal Pit (Airy)	6·565
Torsion balance (Cavendish, 1798)	5·48
,, (Reich, 1838)	5·49
,, (Baily, 1843)	5·66
,, (Cornu and Baille, 1872)	... 5·5—5·56
Method of Weighing (Von Jolly)	5·58
,, (Poynting, 1891)	5·493
,, (Wilsing, 1887-1888) ...	5·58
Rise of Water Level (Berget, 1893)	5·41

Note.—On page 30, column 1, fifth line from bottom, instead of "the earth," *read* "the latter."

THE PHŒNICIANS, OR PALM-TREE PEOPLE.

By J. H. Mitchiner, F.R.A.S.

THE authorities at the British Museum have recently completed an important re-arrangement that must prove of the greatest interest to the student of early civilizations.

Some two thousand years before the Christian era, a branch of the Semitic race, emigrating from the direction of the Persian Gulf, settled on the eastern shores of the Mediterranean Sea. The territory occupied was not large, comprising a coast-line of some three hundred miles, with an average width of about fifteen. But if the area was restricted in size, in character it was most diversified—a land of mountain and flood, possessing a Lebanon (white mountain) range, its highest peak rising ten thousand two hundred feet above the level of the sea. Seen from the Mediterranean, the distinctive feature of the landscape was the luxuriant palms that everywhere flourished indigenous to the soil. Hence the old pre-Homeric mariners from the Ægean named the country "Phœnicia," or "the Land of Palms," and to the people who inhabited it they gave the name of "Phœnicians," or "the Palm-tree People." Here, on this strip of Syrian shore-land, on the slopes of its great southern headland Mount Carmel, on the plains of Samaria and Sharon, and on the banks of the Nahr-el-Litani (Lion River), which rises a short distance from the celebrated ruins of Baalbek, collected, and prospered beyond precedent, this remarkable branch of the Semitic race.

In character, instincts, and prevailing habits the Phœnicians seem to have been the very opposite of the militant Semitic of ancient history, as the belligerent Babylonian, the cruel Assyrian, or that "bitter and hasty nation" the Chaldæans.* Instead of prosecuting wars of conquest and aggression, they were essentially an industrious and peaceable people, everywhere pioneers of civilization, whose whole genius and energy seemed absorbed in commercial activity. Ships, colonies, and commerce formed the ultimate aim of their political constitution, and their cities, Tyre, Sidon, and Aradus, became centres for the business of the then known world. Phœnician colonies multiplied, extending to Spain and Africa. The present city of Cadiz constituted the ancient Gades of Phœnicia, while Carthage, the daughter of Tyre, was founded on the African coast about 800 B.C. The strength of Phœnicia lay in her navy. "Ships of Tarshish" (ancient *Indiamen*) explored the Adriatic, Ægean, and Mediterranean Seas, sailed through the Straits of Gibraltar, and facing the perils of the Atlantic, effected the circumnavigation of Africa.

According to general testimony it is to the Phœnicians that the world is indebted for the invention of the alphabet;† but whether by them derived from the Egyptian hieratic system or from monumental phonetic symbols remains at present a debateable question. M. de Rougé maintains that the primitive form of almost every Semitic letter can be deduced from its normal hieratic prototype. Doubtless the exigencies of increasing commercial intercourse necessitated some simplification of the imperfect and laboured ideographic writing in vogue. A figurative method would dispense with the use of a multitude of tedious phonetic signs. Simplicity was the object to be attained, and we may be quite sure that in the construction of the alphabetical system necessity was the mother of its invention. In common with other Semitic alphabets constructed subsequently on the Phœnician model, it consisted of twenty-two letters, all consonants, and it may be said to have furnished the basis of nearly all other alphabets. The Hebrew is more closely allied to the Phœnician than to any other language; it might, indeed, almost be considered as a dialect of the same tongue. Both alphabets contain twenty-two letters, are without vowels, and the writing reads from right to left. In religion the Phœnicians acknowledged a single deity—one Supreme Power—but the names by which he was known varied with the locality of the temples. El (great) Ram or Rimmon

* Habakkuk i., 6.

† Lucan *Pharsalia*, iii., V., 220, 222. Lemornant, i, 84. Herod, V, 58. Diod. Sic., V., 24. Pliny, H.N., V., 12, VII., 56. Tacitus, Ann. XI., 14. Eusebius, Chron. Can.

XUM

(high), Baal (Lord), Moleck (King), and Adonai (My Lord). As Sun-god, Baal had temples at Baalbek, Tyre, Tarsus, Carthage, and Ekron.

The Phœnician relics in the British Museum—the classification and re-arrangement of which has just been completed—occupy three rooms in the Northern Gallery of the building. The archaic Cyprian sculptures (B.C. 650) are for the most part crude in conception and conventional in execution. The country being destitute of marble, the figures are cut from a calcareous limestone, abounding in holes and fossil shells, quite unfitted for purposes of sculpture. Generally speaking, the bas-reliefs are superior in execution to objects in the round. Most of the faces are depicted with remarkably sharp-pointed noses—a feature even more marked in the terra-cottas. Several heads testify to Assyrian and Egyptian influence; while in the later works (B.C. 150) the results of Hellenistic intercourse is manifest in improved artistic execution.

One of the oldest known alphabetical inscriptions is that of Mesha, King of Moab (B.C. 896), and is known as the Moabite Stone. The original is in the Louvre, but an excellent cast will be found in the Second Room. The stone was discovered by Mr. Klein, a Prussian, at Dibân, a village on the east of the Dead Sea. It is of basalt, rounded at both ends, about three and a half feet in height by two feet in thickness and breadth, having on one face thirty-four lines of inscription, each line about an inch apart. When first seen by Mr. Klein it was in a most perfect state of preservation, not a single piece being broken off. As soon as open efforts were made to secure the treasure, difficulties with conflicting authorities unfortunately arose. Negotiations for its possession were *not* judiciously managed, and ultimately, rather than surrender the stone to the Turkish Government, the Arabs determined to destroy it. They lighted a fire round it, and when sufficiently heated threw on its surface cold water and vinegar, thus causing it to crack and split into fragments. Fortunately a "squeezing" of the inscription had previously been taken by a young *attaché* of the French Consulate, M. Ganneau. In the woodcut are reproduced the first three lines of the inscription. The words are divided from each other by means of points, and the lines or verses by vertical strokes. The whole inscription gives evidence of great fluency, and of long habituation in the use of written characters. Of the undoubted age and genuineness of this interesting relic of antiquity there can be no reasonable doubt. An article by the Rev. A. Löwry on "The Apocryphal Character of the Moabite Stone" appeared in the *Scottish Review* for April, 1887, but the conclusions of the writer are not accepted by other European Semitic scholars.

The stone was erected by Mesha, King of Moab, to commemorate his successes against Omri, King of Israel, and his descendants. This is the same Mesha whose resistance to the united forces of Jehoram, Jehoshaphat, and the King of Edom is recorded in the third chapter of II. Kings. Omri became King of Israel B.C. 929. The date of the stone would be about thirty-nine years afterwards—that is, 890 B.C. The characters of the inscription are Phœnician of the Moabite dialect. The last four lines are undecipherable. There is great similarity between the Moabite and ancient Hebrew writing, which sufficiently explains how it is that in all Biblical references to communications between these people there is no reference on any occasion to an interpreter.

We append a transcription of the whole of the thirty-four lines of writing.

In June, 1880, an important discovery was made in Jerusalem, in the ancient conduit which conveys the water through the hill and under the Mosque of Omar to the Pool of Siloam. The length of the tunnel is one thousand seven hundred and eight feet (five hundred and sixty-nine

The Moabite Stone. B.C. 900.

Analysis of the first three lines.

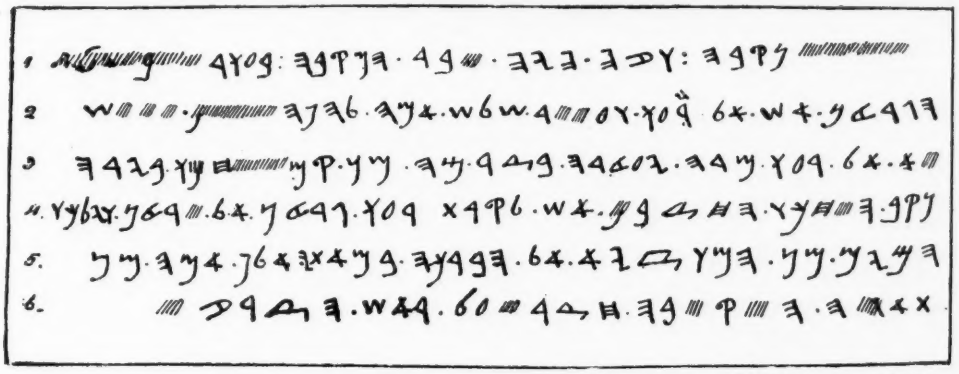
ANoKi MeShA. BeN. KaMoShGaD. MeLeK. Mo'AB [He] D—
—IBoNI | 'ABI. MaLaK, 'AL. Mo'AB ShLiShiN. ShaT V'ANoKi. MaLaK—
TI. 'AChaR. 'ABI.

Translation.

1. I am Mesha, son of Kamoshgad, King of Moab, the D-
2. ibonite | My father reigned over Moab thirty years, and I reign-
3. ed after my father.

yards). It is not straight; the passage winds considerably, and reveals several *culs-de-sac*, showing that the engineering was defective. The inscription (of which a cast will be found in the Second Room in the British Museum) was found in a niche in the wall, about nineteen feet from the mouth of the tunnel where it opens into the Pool of Siloam. A spot, twenty-seven inches by twenty-six, had been prepared in the solid wall on the right hand side of the tunnel as one enters from the Pool, and made smooth to receive the inscription. Being below the water-line, before it could be copied it became necessary to lower the water in the conduit.

According to Prof. Sayce, some of the characters, as *waw*, *zayin*, and *Zsadhê*, are more archaic in shape than the corresponding letters in the Moabite inscription. He therefore regards the tunnel inscription as older than the Moabite Stone, and assigns it to the age of Solomon. It is, however, more generally held to date from about 750 B.C., the time of Hezekiah.



Copy of Inscription of Siloam.

Translation.

1. *Behold the* excavation! Now this is the history of the tunnel. While the excavators *were using*
2. the pick each to his neighbour, and while there were yet three cubits *to be excavated* the voice of one call-
3. ed to his neighbour, for there was *an excess* in the rock on the right. They arose . . . . . they struck on the west of the
4. excavation, the excavators struck each to meet his neighbour, pick to pick, and there flowed
5. the waters from the outlet to the Pool for the distance of 1000 cubits, and . . . . .
6. of a cubit was the height of the rock at the head of the excavation here.

We have here the experience in constructing the Mont Cenis tunnel anticipated by two thousand six hundred years. It is clear the tunnel to the Siloam Pool was commenced simultaneously from both ends; that in consequence of imperfect engineering skill the workmen nearly missed meeting in the centre and overlapped, but, directed by the sound of the picks, altered their course until they joined, and the water flowed throughout the conduit. As might be expected from the difficulty in determining many of the half-obliterated letters, the translation given by Canon Taylor differs somewhat from that of Prof. Sayce, but the general meaning is in no way affected thereby.

An object of considerable interest in the Third Room is the large bronze Lion-weight, of some twenty manehs, engraved with the inscription in Phœnician characters: "Verified in presence of the supervisors of the silver." In the Babylonian Room, close by, are several of these weights, evidently of Phœnician manufacture, of from one to ten manehs each. These were found in Babylonia, and are stamped with the official stamp in both Phœnician and cuneiform characters, and were probably cast exclusively for the Babylonian trade. We know the commerce of the Phœnicians was most extensive. They carried on an active export and import trade with Syria, Judæa, Egypt,

Arabia, Babylonia, Assyria, Mesopotamia, Armenia, Central Asia Minor, Ionia, Cyprus, Hellas, Spain, the Scilly Isles, and the coast of Cornwall. British tin was highly prized, and appears to have secured a monopoly of the markets within Phœnician influence.

There are many other objects and inscriptions also of great interest, as the sarcophagus of the King of Sidon, B.C. 350, the ancient Coptic, Himyritic, Palmyrene, and Hebrew inscriptions, all of which are admirably arranged, and form a deeply instructive chapter in the book of the past.

THE ROOT-TUBERCLES OF PEAS AND BEANS.*

Part II.—*Continued from page* 70.

By J. Pentland Smith, M.A., B.Sc.

THE life-history, so far as it is known, of the organism that is the cause of the formation of these tubercles has been worked out by Prof. Marshall Ward, Prazmowski, and others, while Lawes and Gilbert, Berthelot, and Warrington have studied its life-history from the chemical standpoint.

The nodules vary in size. Last month we gave a photograph of the roots of a pea with badly-developed tubercles. Fig. 1 shows a well-grown tubercle on the root of a bean. This is seen in transverse section in the next illustration (Fig. 2). At *a* the cells of the tubercle are still growing, and almost free from the irritating organism; lower down in the tissues are found thread-like bodies (hyphæ), and still further towards the base the parasite has been very active. Fig. 3 is a partly diagrammatic section of a root with a tubercle on one side, and with a rootlet arising from another portion. In the centre of the root is the axile vascular bundle of the usual type, composed of alternating patches of xylem (wood) and phloëm (soft bast); around this is the cortex (bark), through which the root has pierced. The lateral root arises opposite a xylem strand. Two stages in the development of the tubercle-causing organism are seen in the nodule. On the outside is the cortex, continuous with that of the root, and exhibiting a zone of merismatic tissue—that is, a tissue composed of cells dividing up to form new cells. In the cells internal to this, hyphæ are seen from which minute corpuscular bodies are being budded off. This process will be seen more distinctly in another figure. Still nearer the point of

I.

Fig. 1.—Tubercle on the root of a Bean.

II

Fig. 2.—Vertical section of Tubercle on root of Bean.

* I am indebted to Prof. Marshall Ward, F.R.S., etc., for his kind permission to copy the figures illustrative of his monograph on the "Root-Tubercles of the Leguminosæ," in the *Transactions of the Royal Society* for 1887.

origin from the root the cells are filled with small corpuscles, which have been called bacteroids, from their resemblance to bacteria. If the specimen under examination is fresh, these corpuscles are to be seen in active motion, but a high power of the microscope is necessary to observe them properly. The corpuscles are of various forms, as shown in Fig. 4; some are spherical, others are larger and shaped like the letter Y. The spherical corpuscles were found in tubercles formed some time ago; the Y-shaped in the freshly-formed nodules. A much magnified view of some cells filled with bacteroids is given in Fig. 5. They were taken from the inner portion of the tubercle shown in Fig. 3. The densely granular nature of the cell contents is due to the enormous development of the bacteroids. These have preyed upon the cell contents, causing a flow of nourishing matter to the cells, resulting in their abnormal enlargement. The open spaces in the cells are termed "vacuoles"; they are filled with a watery fluid. The black body is spoken of as the "nucleus."

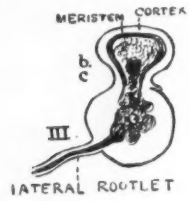


Fig. 3.—Cross section of Tubercle on root of Bean.

Tubercles have been found on the roots of all leguminous plants when grown in the open; but under certain experimental conditions the tubercles are not to be found. Thus when the seeds are germinated in sand or cocoanut fibre (sterilized), and are then carefully washed and watered with distilled water, containing nourishing salts in solution, the young plants will grow, if well provided with all the elements necessary for their development. But no tubercles will be formed when these precautions are carefully observed, and the water used has been properly sterilized. If, however, the plant is infected by contact with other tubercles, or a small quantity of garden soil be introduced into the culture medium, the formation of nodules at once takes place, and it has been shown by Prof. Marshall Ward that the act of infection is a perfectly definite one. Figs. 6, 7, and 8 show that the infection consists in the distortion of the cell-wall of a root-hair at one portion where a brilliant dot is noticed. From this point a fine tube passes down the cavity of the root-hair. It then passes through the cell-wall and into the underlying cortical cells, its tip ultimately reaching the innermost cells of this portion of the root. There it branches into the neighbouring cells, and the irritation set up causes them to renew their activity; they divide up and form the mass of the tubercle. In the cell-wall of one of the cells depicted in Fig. 6 the hypha is first seen to branch, and it is not an uncommon thing to find, as in one of these branches, the hypha attached to the nucleus. Where the hyphæ penetrate the walls of the cells peculiar trumpet-shaped widenings may be noticed, suggesting the idea that after the hyphæ had passed through them the cell-walls of the still growing cells had stretched out. Referring to Fig. 8, we see a peculiar "trumpet-shaped widening" of the cell-wall of the root-hair where the organism has obtained an entrance into the interior.

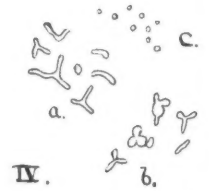


Fig. 4.—Bacteroids from cells of Tubercles.

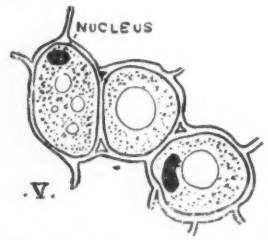


Fig. 5.—Much magnified section of cells containing Bacteroids.

So far, then, we have seen that peculiar brilliant spots are noticeable on certain of the root-hairs of plants affected by this organism; that from these a tube passes down into the tissues of the root; that it branches in the inner layers of the cortex, and stimulates the attached cells much in the same way as does *Plasmodiophora brassicæ*, the cause of the disease known as club-root, or fingers and toes on the turnip and allied plants. We have also seen that in the outer cells of a still healthy tubercle hyphæ are present along with minute corpuscular bodies, which are termed "bacteroids," and that, further, the bacteroids found in a tubercle of the current year are peculiarly shaped, whilst those found in old tubercles are spherical.

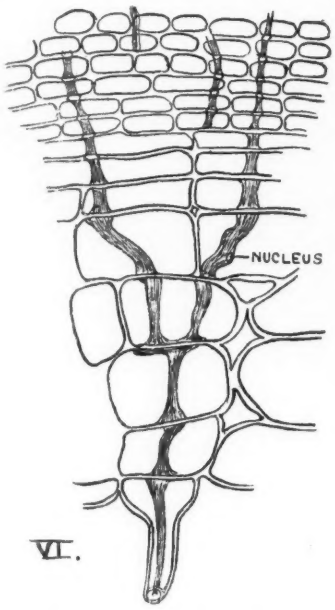


Fig. 6.—Section of root showing hypha penetrating cells.

We now come to the examination of a preparation which helps to throw some light on the formation of the bacteroids. If we turn to Fig. 9 we shall see a very much magnified view of a few cells from the dark shaded portion of the tubercle of Fig. 3. The protoplasm of the cells is very granular with bacteroids, and in the majority of cases contains many vacuoles. Furthermore, two branching hyphæ are visible, which appear to be budding off from their tips minute bacteroids. At this stage it appears that starch often accumulates in the cells of the tubercle, and that the nucleus occasionally undergoes a fatty degeneration. The widening of the hypha in its passage through the cell-wall is more clearly seen in the next figure (Fig. 10), and in the subsequent ones, Figs. 11 and 12, we have a more enlarged view of the process of budding off of the bacteroids at the tips of the hyphæ.

In the *Botanisches Centralblatt* for 1888 there is a paper of Prof. Prazmowski's which confirms in the main the statements of the life-history as worked out by Prof. Marshall Ward, from whose paper in the *Philosophical Transactions* we have borrowed our illustrations, but he differs in some details. Marshall Ward, for example, states

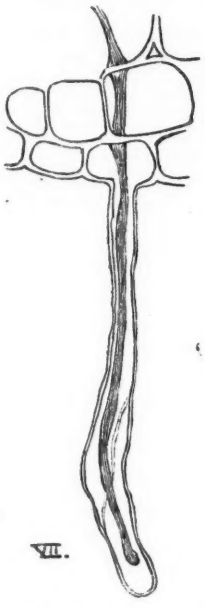


Fig. 7.—Section of root-hair and cells, with penetrating hypha.

that the bacteroids are budded off from the hyphæ, whereas Prazmowski conjectures that they are formed from their contents inside them; this, however, is a mere supposition. Prazmowski states that he has not observed their development directly, although he has taken the trouble to cultivate them in very different nourishing media and under the most variable conditions; but this is not to be wondered at when we consider that these organisms are amongst the most minute in the vegetable kingdom.

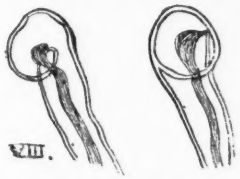


Fig. 8. — Root-hair with trumpet-shaped widening.

Experiments were afterwards instituted (in 1888) by Marshall Ward for the purpose of determining what relation existed between the tubercle-forming organism of the bean and pea respectively, and they resulted in the conclusion that they were one and the same. It was also noticed that the young root-hairs, with delicate cell-walls, are especially liable to be attacked; that at the place of infection a brilliant spot makes its appearance, as previously stated. If this is not one of the bacteroids it is difficult to say what it is. The resulting tube grows down the cavity of the root-hair, developing at the expense of the cell contents.

In the lichens we have a fungus and an alga growing together, the well-being of the fungus dependent on that of the alga, and *vice versâ*. The fungal portion alone produces the sexual organs of the lichen; the fungus extracts nourishment from the substratum, while the algal portion decomposing the carbonic acid of the air provides at least a large amount of the carbon necessary for the growth of the compound organism. Two organisms growing together in this fashion are said to live a symbiotic existence. There are many examples of such partnerships in the vegetable kingdom, though sometimes the partnership is only helpful to one of the symbionts, as in the case of all parasites.

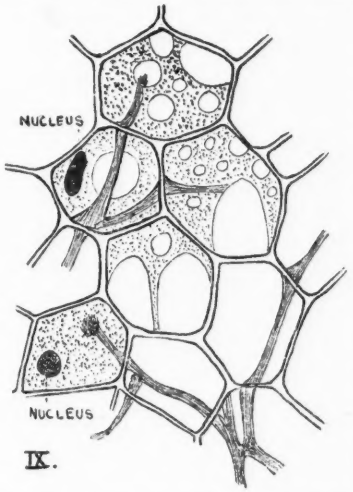


Fig. 9. — Magnified view of cells from tubercle with branching hyphæ.

From researches conducted in 1888 and 1889, by Prof. Marshall Ward, we have learnt more about the conditions which rule the development of the tubercle and the relations of the organisms to them. It was proved that the relation between the organism and the host plant are of the most intimate kind, and that the well-being of the one depends upon that of the other. For instance, if the growth of the plant were so modified that no more carbonaceous material was assimilated than it required for its own development, then that of the tubercles was arrested, and they were found to be very deficient in bacteroids. In one experiment a stream of air was passed through the water in which the plants were being cultivated. This caused the plants to grow rapidly, but the amount of carbon assimilation being disproportionate to their growth, either no tubercles were formed or only very small specimens made their appearance.

It may be interesting to note a number of experiments actually made in this connection by Prof. Marshall Ward in 1889:—

"Six peas were placed in garden soil.

"Six peas were placed in silver sand with cultural salts including a nitrate.

"Six peas were grown similarly in silver sand with cultural salts but *without* a nitrate.

"Six peas were placed in sand with traces of soil washings or with pieces of tubercle added.

"Six peas were placed in sand sterilized by heating.

"Six peas were placed in sand to which salts (including a nitrate) were added."

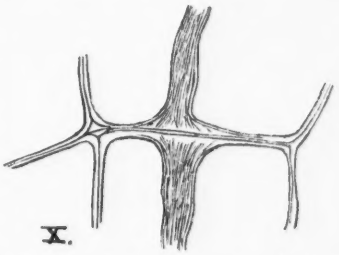


Fig. 10.—Section showing the widening of the hypha on passing through cell-wall.

On all the plants grown, with the exception of those in the sterilized media, tubercles made their appearance. It was also shown that if the plant and cultural medium is regarded as one system, there is a gain of nitrogen either in the crop or in the medium surrounding the roots. This nitrogen must have been taken from the air. So far as we know, the green plants themselves are unable to effect such a gain, and we must conclude that its assimilation was due to the tubercle-forming organism; but where does it get the energy to enable it to perform this operation? This seems to be derived from the protoplasm of the cells of the green plant upon which it lives, and which it in turn benefits by the nitrates assimilated. The precise method in which the assimilation of the nitrogen of the air is effected is still a mystery. When an element is liberated owing to the decomposition of a compound, it is said to be in a nascent condition. Now it is known that hydrogen when in this state possesses especially powerful properties, enabling it to effect unions with other elements, or to decompose compounds which it could not under ordinary circumstances attack; and it has been recently asserted by Windogradsky that in this condition hydrogen unites with nitrogen in the living protoplasm of the bacteroids. If so, the result would probably be the formation of ammonia, which would unite with salts derived from the soil, and thus the nitrogen would become a source of food to the green symbiont.

Prazmowski asserts that he has succeeded in cultivating the bacteroids in nourishing media, and that they divide indefinitely, appearing as minute motile rods, and he accordingly places them amongst the Schizomycetes or fission fungi, the group to which bacteria belong. But it

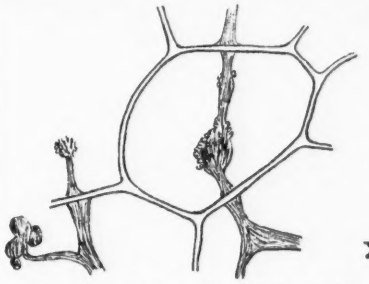


Fig. 11.—Section showing bacteroids budding off from hyphæ.

should be mentioned that Prof. Marshall Ward has not confidence in his cultures, and does not seem inclined to give these minute bodies a similar place in his classification of organisms.

It may be noted in conclusion that the leguminous plant, being the stronger of the two symbionts, directs the growth. It provides space in which the bacteroids may develop by means of the zone of merismatic cells, and it encloses them in a corky tissue, so that their development may go on undisturbed by external influences.

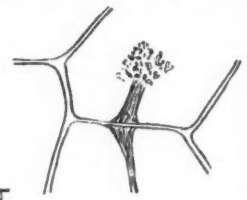


Fig. 12.—Section showing bacteroids budding from tip of hypha.

At the death of the bacteroids the plant absorbs the nourishing matter provided by them, and thus is a distinct gainer in the matter of assimilated nitrogen. Further, the tubercles being situated near the vascular bundle, a ready source of nutrient material, in the form of carbo-hydrates (elaborated in the leaves), is always open to bacteroids, and at the same time the products of decomposition of their bodies can be conveyed to the green plant as required.

THE FACE OF THE SKY FOR APRIL.

By Herbert Sadler, F.R.A.S.

A MAGNIFICENT group of sunspots has lately been visible on the Sun's disc. An annular eclipse of the Sun will occur on the 5th, but no portion of it will be visible in these islands. Conveniently observable minima of Algol occur at 11h. 6m. P.M. on the 6th, at 7h. 55m. P.M. on the 9th, and at 9h. 37m. P.M. on the 29th.

Mercury is a morning star in the sense of its rising before the Sun, and is at his greatest western elongation (27½°) on the 10th, but as during the whole month he does not rise more than forty minutes before the Sun, he cannot be detected by the naked eye.

Venus is a morning star, but is decreasing in apparent diameter and brilliancy, her brightness at the end of the month being about two-thirds of what it was towards the end of March. She is at her greatest western elongation (46¼°) on the 27th. On the 1st she rises at 4h. 3m. A.M., or 1h. 35m. before the Sun, with a southern declination of 8° 57′, and an apparent diameter of 33½″, $\frac{33}{100}$ths of the disc being illuminated, and her brightness being about equal to what it was on January 21st. On the 11th she rises at 3h. 48m. A.M., or 1h. 27m. before the Sun, with a southern declination of 7° 32′, and an apparent diameter of 29½″, $\frac{4}{10}$ths of the disc being illuminated, and the brightness of the planet being about equal to what it was on March 11th. On the 21st she rises at 3h. 32m. A.M., or 1h. 23m. before the Sun, with a southern declination of 5° 16′, and an apparent diameter of 25½″, $\frac{46}{100}$ths of the disc being illuminated, and her brightness being about equal to what it was on March 7th. On the 30th she rises at 3h. 17m. A.M., or 1h. 20m. before the Sun, with a southern declination of 2° 39′, and an apparent diameter of 23″, $\frac{81}{100}$ths of the disc being illuminated. During the month Venus pursues a direct path through part of Aquarius into Pisces. On the morning of the 4th she is very near the 4½ magnitude star θ Aquarii, and on the following morning the 5½ magnitude star ρ Aquarii.

Mars is, for the purposes of the amateur observer, invisible.

Jupiter is an evening star, but is so rapidly approaching the Sun that we only give an ephemeris of him for the first half of the month. While visible he pursues a direct path in Taurus, through a region barren of naked eye stars. On the 1st he sets at 11h. 1m. P.M., with a northern declination of 19° 23′, and an apparent equatorial diameter of 34½″. On the 15th he sets at 10h. 23m. P.M., with a northern declination of 20° 8′, and an apparent equatorial diameter of 33″. The following phenomena of the satellites occur up to the 15th, while the planet is more than 8° above and the Sun 8° below the horizon:—On the 2nd an occultation disappearance of the second satellite at 9h. 16m. P.M. On the 3rd a transit ingress of the shadow of the first satellite at 7h. 23m. P.M., a transit egress of the second satellite itself at 8h. 38m. P.M., and of its shadow at 9h. 36m. P.M. On the 5th an occultation disappearance of the second satellite at 9h. 24m. P.M. On the 6th a transit ingress of the shadow of the third satellite at 7h. 32m. P.M., and its transit egress at 9h. 37m. P.M. On the 7th a transit egress of the shadow of the second satellite at 8h. 53m. P.M. On the 10th a transit ingress of the first satellite at 8h. 25m. P.M., and of its shadow at 9h. 18m. P.M. On the 11th an eclipse reappearance of the first satellite at 8h. 49m. 57s. P.M. On the 13th a transit ingress of the third satellite at 8h. 6m. P.M. On the 14th a transit ingress of the shadow of the second satellite at 9h. 6m. P.M.

Saturn is an evening star, rising on the 1st at 7h. 14m. P.M., with a southern declination of 6° 14′, and an apparent equatorial diameter of 18·7″ (the major axis of the ring system being 43″ in diameter, and the minor 9¾″). On the 15th he rises at 6h. 13m. P.M., with a southern declination of 5° 50′, and an apparent equatorial diameter of 18·7″ (the major axis of the ring system being 43″ in diameter, and the minor 9½″). On the 30th he rises at 5h. 8m. P.M., with a southern declination of 5° 26′, and an apparent equatorial diameter of 18·6″ (the major axis of the ring system being 43″ in diameter, and the minor 9″). On the evening of the 11th the 6½ magnitude star 72 Virginis will be about ½′ south of Saturn, and at 10h. P.M. there will be a conjunction of this star with Rhea. Iapetus is at his eastern elongation on the 9th, and in inferior conjunction on the 27th. Saturn is in opposition on the 11th, at a distance from the earth of about 808 millions of miles. During the month Saturn pursues a retrograde path in Virgo, being about 23′ south of 74 Virginis, 5th magnitude, on the 6th.

Uranus is an evening star, and but for his southern declination would be favourably placed for observation. On the 1st he rises at 9h. 26m. P.M., with a southern declination of 15° 51′, and an apparent diameter of 3·8″. On the 30th he rises at 7h. 26m. P.M., with a southern declination of 15° 30′. During the month he pursues a retrograde path in Libra, up to and beyond α^2. He is in conjunction with α^2 Libræ (3·0 magnitude) at 1h. P.M. on the 27th, of course in bright sunlight, and at 10h. P.M. he is only 3·0s. *p.* and 4′ 20″ north of it. At 8h. P.M. on the 28th he is in conjunction with α^1 (5·3 magnitude) at 6h. P.M., 2′ 15″ to the north, but the asterism does not rise till about 7h. 30m. P.M. At 10h. P.M. that evening he will be 1·7s. *p.* and 2′ 23″ north of α^1. As α^1 and Uranus are nearly of the same magnitude and colour, this, if the weather be clear, will prove a very interesting phenomenon, especially as the Moon will be absent. α^1 α^2 Libræ form a wide double, not, however, divisible with the naked eye on account of the inequality of the stars, 231″ apart in the direction of 314½°. A map of the stars near the path of

Uranus, and a diagram of the conjunction, will be found in the *English Mechanic* for March 23rd.

Neptune is an evening star, but should be looked for as soon after sunset as possible. He sets on the 1st at 11h. 57m. P.M., with a northern declination of 20° 40′, and an apparent diameter of 2·5″. On the 30th he sets at 10h. 11m. P.M., with a northern declination of 20° 48′. A map of the small stars near his path will be found in the *English Mechanic* for December 29th, 1893.

Shooting stars are fairly plentiful in April, the best marked shower being that of the Lyrids, with a radiant point in R.A. 18h. + 33°. The radiant point rises on the evenings of the 19th and 20th, when the maximum occurs, at about 6h. 27m. P.M., and souths at 4h. 8m. A.M.

The Moon is new at 4h. A.M. on the 6th; enters her first quarter at 0h. 33m. A.M. on the 13th; is full at 3h. 2m. A.M. on the 20th; and enters her last quarter at 3h. 20m. A.M. on the 28th. She is in perigee at 3h. A.M. on the 11th (distance from the earth 229,280 miles), and in apogee at 8h. A.M. on the 26th (distance from the earth 251,330 miles). At 4h. 19m. on the 2nd the $6\frac{1}{2}$ magnitude star 29 Aquarii will disappear at an angle of 66° from the north point (the star being below the horizon at the time), and reappear at 5h. 27m. A.M. (10 minutes before sunrise) at an angle of 252°. At 7h. 4m. P.M. on the 9th the $5\frac{1}{2}$ magnitude star χ^1 Tauri will disappear at an angle of 67°, and reappear at 8h. 4m. P.M. at an angle of 278°. At 10h. 54m. P.M. on the 10th the $6\frac{1}{2}$ magnitude star B.A.C. 1746 will disappear at an angle of 92°, and reappear at 11h. 44m. P.M. at an angle of 273°. At 8h. 40m. P.M. on the 11th the $5\frac{1}{2}$ magnitude star 49 Aurigæ will disappear at an angle of 76°, and reappear at 9h. 37m. P.M. at an angle of 305°. At 10h. 52m. P.M. on the 12th the 6th magnitude star 76 (*c.*) Geminorum will disappear at an angle of 111°, and reappear at 11h. 49m. P.M. at an angle of 286°. At 8h. 42m. P.M. on the 16th the 4th magnitude star σ Leonis will disappear at an angle of 78°, and reappear at 9h. 29m. P.M. at an angle of 357°. At 4h. 28m. A.M. on the 19th the 6th magnitude star B.A.C. 4394 will disappear at an angle of 106°, and reappear at 5h. 25m. A.M. (the star being below the horizon) at an angle of 306°. At 3h. 2m. A.M. on the 29th the 5th magnitude star κ Capricorni will disappear at an angle of 53°, and reappear at 4h. 13m. A.M. at an angle of 264°.

Errata.—In Knowledge for February, page 47, column 2, *for* "The Moon . . . on the 3rd" *read* "The Moon . . . on the 5th." In Knowledge for March, page 70, column 1, last line, *for* "19° of arc" *read* "19′ of arc"; page 71, column 1, three lines from bottom of column, *for* "5h. 16m." *read* "5h. 13m."

Chess Column.

By C. D. Locock, B.A.Oxon.

Communications for this column should be addressed to C. D. Locock, Burwash, Sussex, and posted on or before the 12th of each month.

Solution of Problem No. 11.

Key-move—1. R to B6.

If 1. . . . P×R,	2. Q×KPch.
1. . . . K to B5 (or Kt×Kt &c).	2. Q to Kt5ch.
1. . . . Q moves, &c.	2. Kt (Q6) to B5ch.
1. . . . Kt (Q8) moves	2. Q—B2 mate.

Solution of Problem No. 12.

Key-move—1. P to Kt4.

If 1. . . . K×R,	2. Q—Q5
1. . . . P×R,	2. B to R2ch.
1. . . . P to Kt4,	2. Q to R5ch.
1. . . . Anything else,	2. Q to K8ch.

Solution of Problem No. 13.

Key-move—1. Q to K8.

If 1. . . . RP×P,	2. Kt—Kt3ch.
1. . . . KtP×P,	2. Kt to B3ch.
1. . . . B×P,	2. Q×P
1. . . . B to Kt5	2. Q to B6ch.
1. . . . B to B4,	2. Q to B6 or R8 mate.

Dual after 1. . . K to B4 by 2. Kt to B3 or B to B3.
Also after 1. . . K to Q4 by 2. Kt to Kt3 or B to Q3.

We congratulate the three solvers (*not* the leading triumvirate) who discovered these duals.

As explained fully in the February number, the dual *short mate* does not count.

Correct Solutions received from the following:—

Eleven Points.—A. C. Challenger, E. W. Brook.

Ten Points.—H. Holmes.

Nine Points.—J. H. Christie, L. Bourne, Chat, Alpha, B. G. Laws, Semper, Guy, W. T. Hurley. Kt. J.

Six Points.—A Norseman.

The correct keys were also sent by A. R., but unfortunately too late for competitive purposes.

H. S. Brandreth.—Your solutions this month are painfully incorrect. In No. 11. After 1. R to K8, Kt×R; 2. B×Kt, Q to R3 (!). In No. 12. After 1. Q to KB8, P×R, Black has the better game, though White may draw. In No. 13. After 1. Q to KB8, Black may play almost anything except B×P, KtP×P, and of course B to B4.

H. Holmes.—In No. 11, we would suggest 1. . . . K to B5 in reply to 1. P Queens. If then 2. Q×QP, Q to R3. Unless you can *prove* that your move solves the problem, the deduction of one point for the incorrect claim must hold good.

A Norseman.—In reply to (No. 11) 1. Kt to QKt7 1. . . . P to Q3 looks a strong defence. The post-card referred to has not been received.

A. R.—The adverse decision in your case seems necessary, though much to be regretted. Your presence on the "Jury" will be most desirable; it is to be hoped, therefore, that with this end in view you will send solutions of the remaining six problems.

Leading Solvers' Scores.

Guy	51	H. Holmes	41
B. G. Laws	51	J. H. Christie ...	39
Semper	51	A. R.*	35
A. C. Challenger ...	50	E. W. Brook† ...	35
Kt. J.	48	A Norseman ...	34
W. T. Hurley ...	47	L. Bourne	31
Chat	45		

* Three solutions too late to count. † Did not send solutions of Nos. 1 and 2.

It is satisfactory to note that the supremacy of the three leaders is not allowed to continue unchallenged. One of

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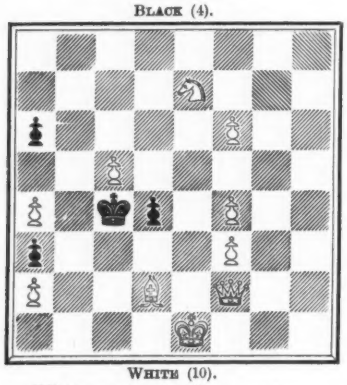
them remarks on the singularity of the fact that they missed two duals in the first eight sound problems. But four duals missed in eleven problems is still more strange, and certainly unusual.

Position No. 14.

"*Enrichetta.*"

Black (4).



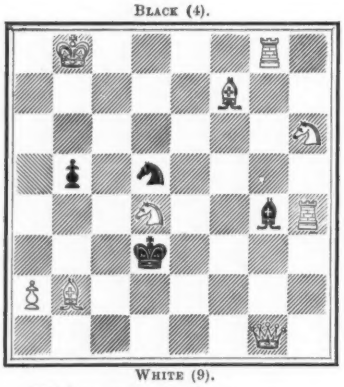
White (10).

White mates in three moves.

Position No. 15.

"*The Circle.*"

Black (4).



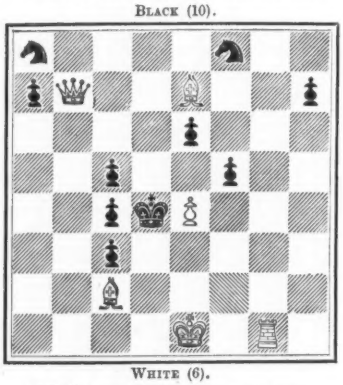
White (9).

White mates in three moves.

Position No. 16.

"*A Norseman's a Chess-Piece.*"

Black (10).



White (6).

White mates in three moves.

[The three Problems in the May number will conclude the series.]

CHESS INTELLIGENCE.

The long-discussed match between Messrs. Steinitz and Lasker for the championship of the world has not only been arranged, but no sooner arranged than begun. The match goes to the winner of the first ten games, draws of course not counting. The first portion of the contest takes place at New York.

In the Southern Counties' Chess Union, Sussex defeated Kent, at Redhill, without very much difficulty. The match between Hants and Surrey is still undecided, the result depending on the interpretation of the time-limit rule in the case of the game played at the top board.

The Inter-University Chess Match took place at the British Chess Club on March 16th, Cambridge winning by a bare majority. The following was the score:—

Oxford.	won	Cambridge.	won
G. H. Higginbotham, Pembroke	0	H. E. Atkins, Peterhouse	1
R. G. Lynam, St. Catharine's.	½	P. H. Dyke, King's ...	½
P. W. Sergeant, Trinity	½	H. J. Snowdon, Queen's	½
W. Poynton, Exeter ...	0	L. W. P. Lewis, Peterhouse	1
E. Lawton	1	A. B. Ramsay, King's	0
G. H. Cooper, Oriel ...	0	H. V. Naish, Emmanuel	1
J. H. Wetherall, Exeter	1	G. Varley, Christ's ...	0
Total ...	3	Total ...	4

On March 14th took place what was intended to be the decisive battle for the London Club Championship. The teams opposed were the City of London Chess Club and the Metropolitan Chess Club, both of which had won all their previous matches in the competition. The teams as usual consisted of twenty players a side, and when time was called after three hours' play it was found that the only five games finished had resulted in draws. After some discussion of this most unsatisfactory result, it was finally decided that the match should be replayed at some future date. Obviously three hours' play is insufficient for an important contest between equally matched teams. If both sides take their full time, only thirty moves can be played in each game, a number which is seldom quite decisive between fairly even opponents.

The North *v.* South match of one hundred and ten players a side takes place at the Portman Rooms, W., on April 7th. On the day before, the annual match between Old Oxonians and Old Cantabs takes place.

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